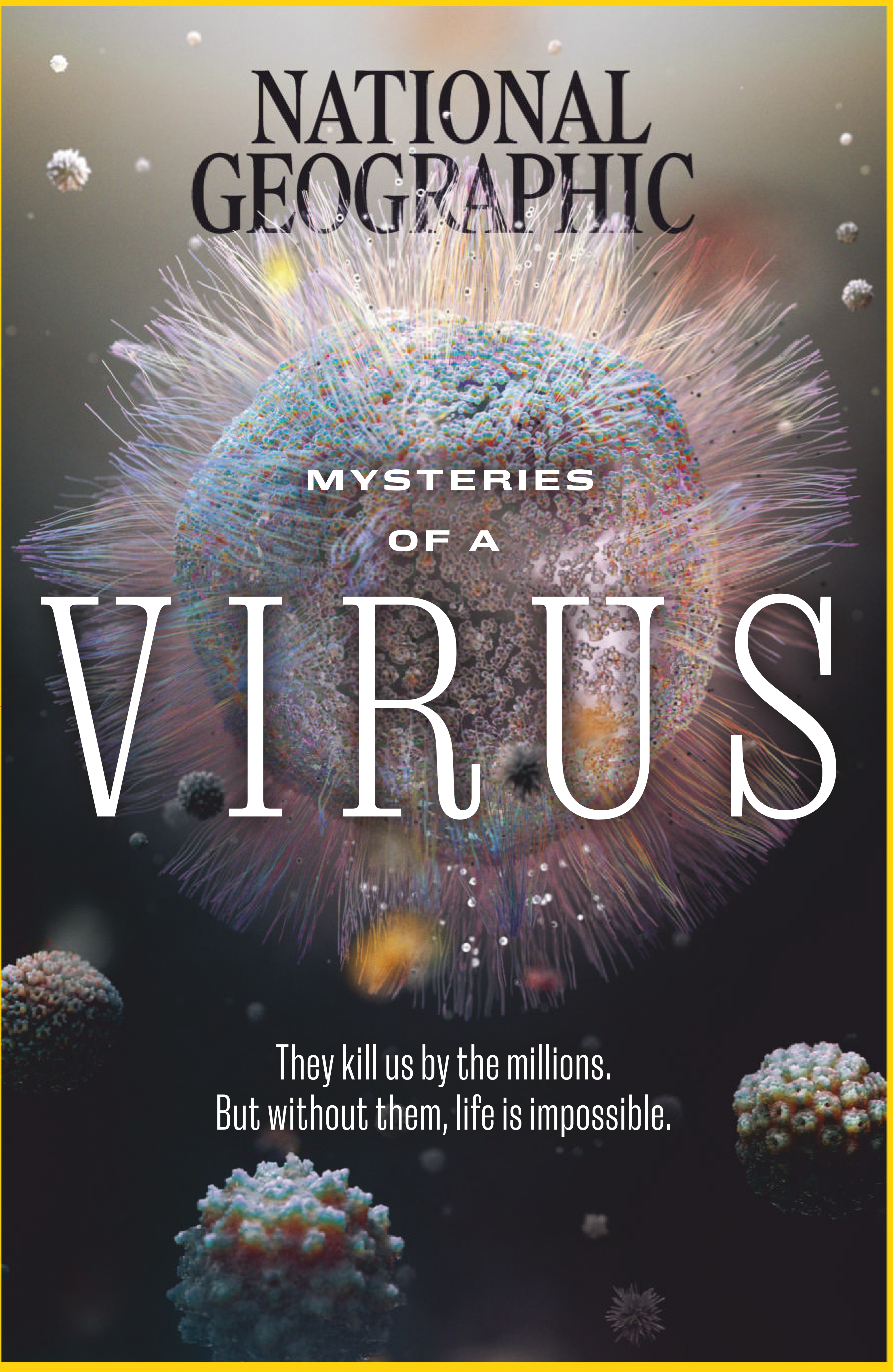
02.2021

NATIONAL GEOGRAPHIC



MYSTERIES OF A VIRUS

They kill us by the millions.
But without them, life is impossible.

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The premium cat food that's always on their mind. SHEBA® Perfect Portions™ What Cats Want™

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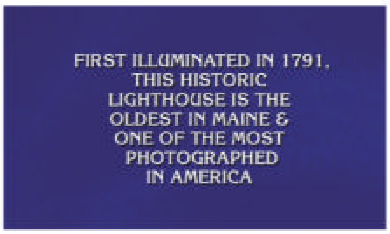
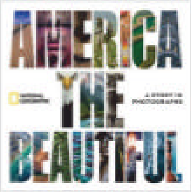
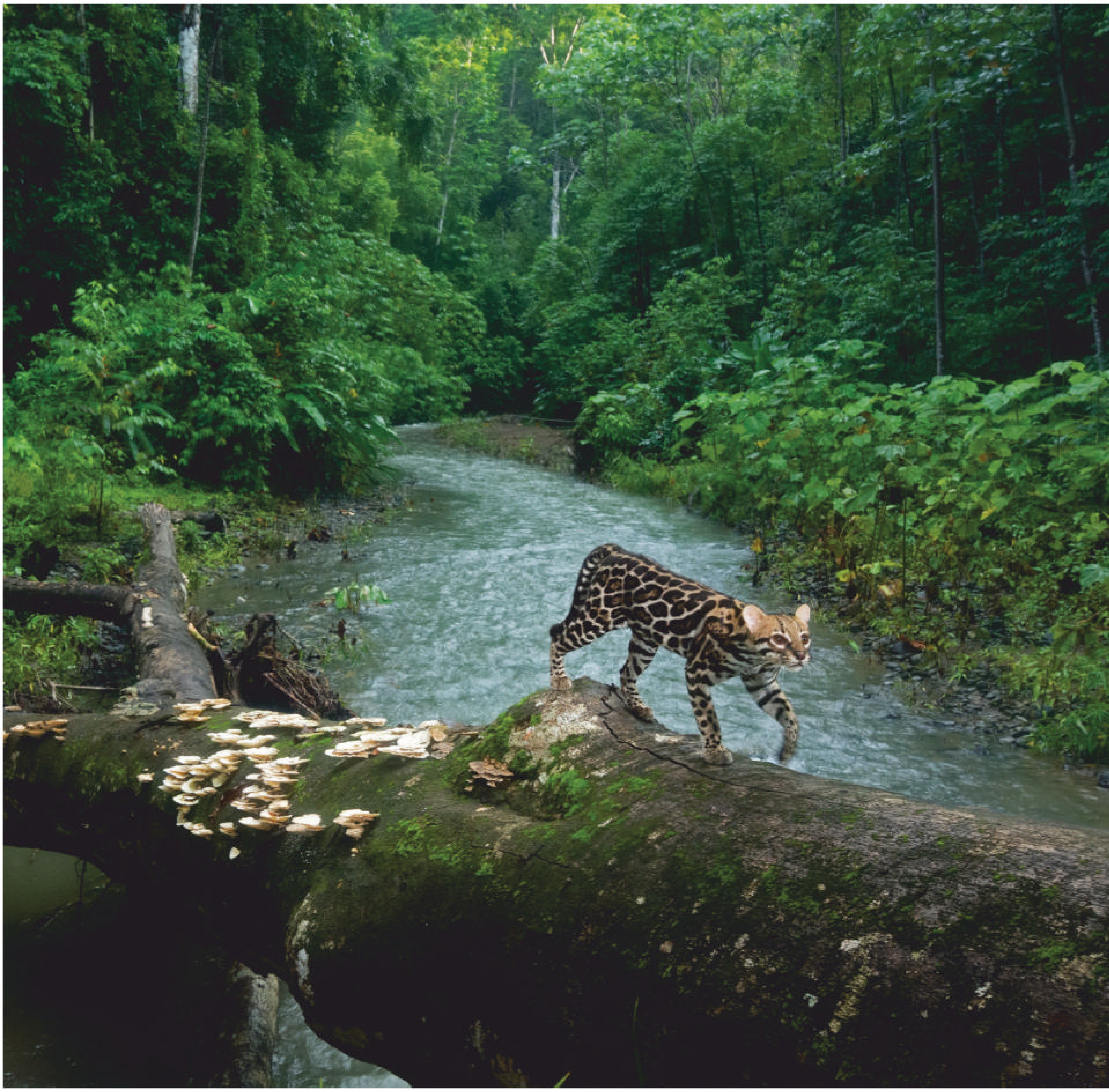


FIRST ILLUMINATED IN 1791, THIS HISTORIC LIGHTHOUSE IS THE OLDEST IN MAINE & ONE OF THE MOST PHOTOGRAPHED IN AMERICA

Can you answer this JEOPARDY! clue?
Watch *Jeopardy!* the week of February 1-5 for clues about the new National Geographic book *America the Beautiful: A Story in Photographs.* Full of stunning images and inspiring words from luminaries, it's available wherever books are sold. (Answer below.)



WHAT IS PORTLAND HEAD LIGHT?



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MONUMENTS

Reconsidering Symbols of the Past

BY **SUSAN GOLDBERG** PHOTOGRAPHS BY **KRIS GRAVES**

IN LEXINGTON, VIRGINIA, a three-hour drive southwest of National Geographic headquarters in Washington, D.C., the ground is shifting in a way that turns history into headlines.

In December 2020 the Virginia Military Institute removed a statue of one of its past teachers: Army Gen. “Stonewall” Jackson, a Confederate leader in the Civil War and owner of enslaved people. The statue had been on campus since 1912; until a few years ago, cadets at the taxpayer-supported school were expected to salute it as they passed.

The decision to relocate Jackson’s statue to a museum followed an October ruling to allow Virginia’s governor to remove a large statue of Gen. Robert E. Lee from state-owned land in Richmond, the former Confederate capital.

Discussions about what to do with Confederate iconography like these statues have been going on for years. It seemed little ever changed. But last May, the nation saw the recorded death of a Black man named George Floyd, who drew his last breath under the knee of a Minneapolis police officer. Suddenly, all that talk exploded into determination to do something about physical symbols of white supremacy, such as monuments honoring those who fought in the Civil War for the right to enslave Black people.

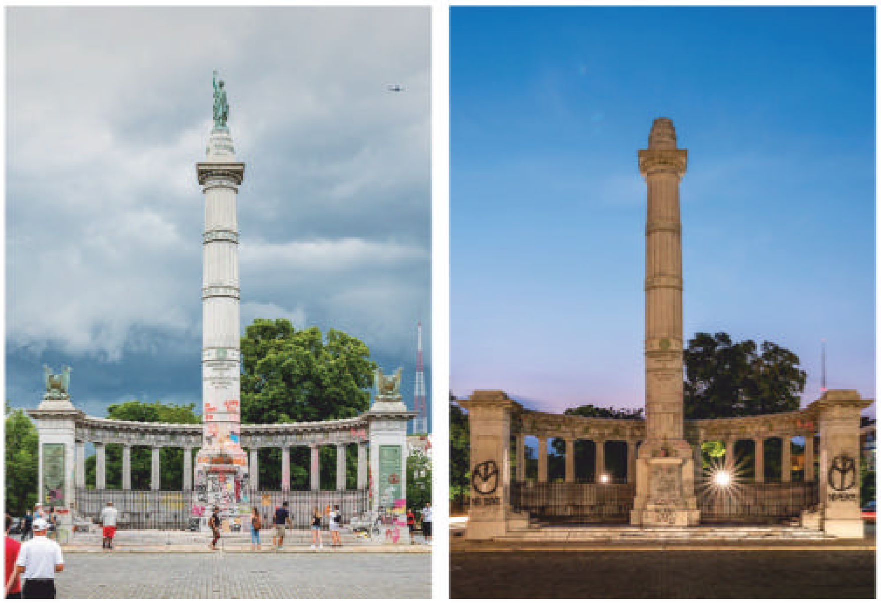
“The questions about our history endure,” Phillip Morris writes in this issue. “What symbols from our past should be reconsidered or discarded? What stories demand a more complete and honest retelling? How should history be taught or more fully contextualized?” Morris and photographer Kris Graves went looking for answers and found plenty of material to work with.

There are at least 1,940 memorials, statues, and other public symbols of the Confederacy in more than 30 states and Washington, D.C. Many honor Lee, Jackson, and Confederate president Jefferson Davis. But, as Morris notes, “lesser Confederate tributes quietly blend into the national fabric marking city boulevards, state routes, and federal highways” across the country. And that doesn’t count the 10 military bases and over a hundred public schools, universities, and parks named for Confederates.

By the time you read this, more statues may have been removed, more edifices and roads renamed. Scrutiny of past leaders—George Washington, Theodore Roosevelt, Christopher Columbus—is growing, Morris writes, as more “institutions, nations, and historians seem ready to embrace a deconstruction of the past to better understand and improve the present and future.”

As some monuments are removed, I hope more new ones will be erected, telling the stories of people we may not know about because their lives were rendered invisible. We’ll be well served by bringing their histories into the light.

Thank you for reading *National Geographic.* ☐



When the Jefferson Davis monument in Richmond, Virginia, was unveiled on June 3, 1907, its central figure was a statue of the onetime Confederate president, and the female figure atop its granite column was said to represent divine vindication of the South. The photo above left was made after protesters knocked the Davis statue off its graffitied pedestal on June 10, 2020. About a month later (right), the Vindicatrix figure had been removed by a public works crew.

PROOF

NATIONAL GEOGRAPHIC

PHOTOGRAPHS BY **NICK KNIGHT**

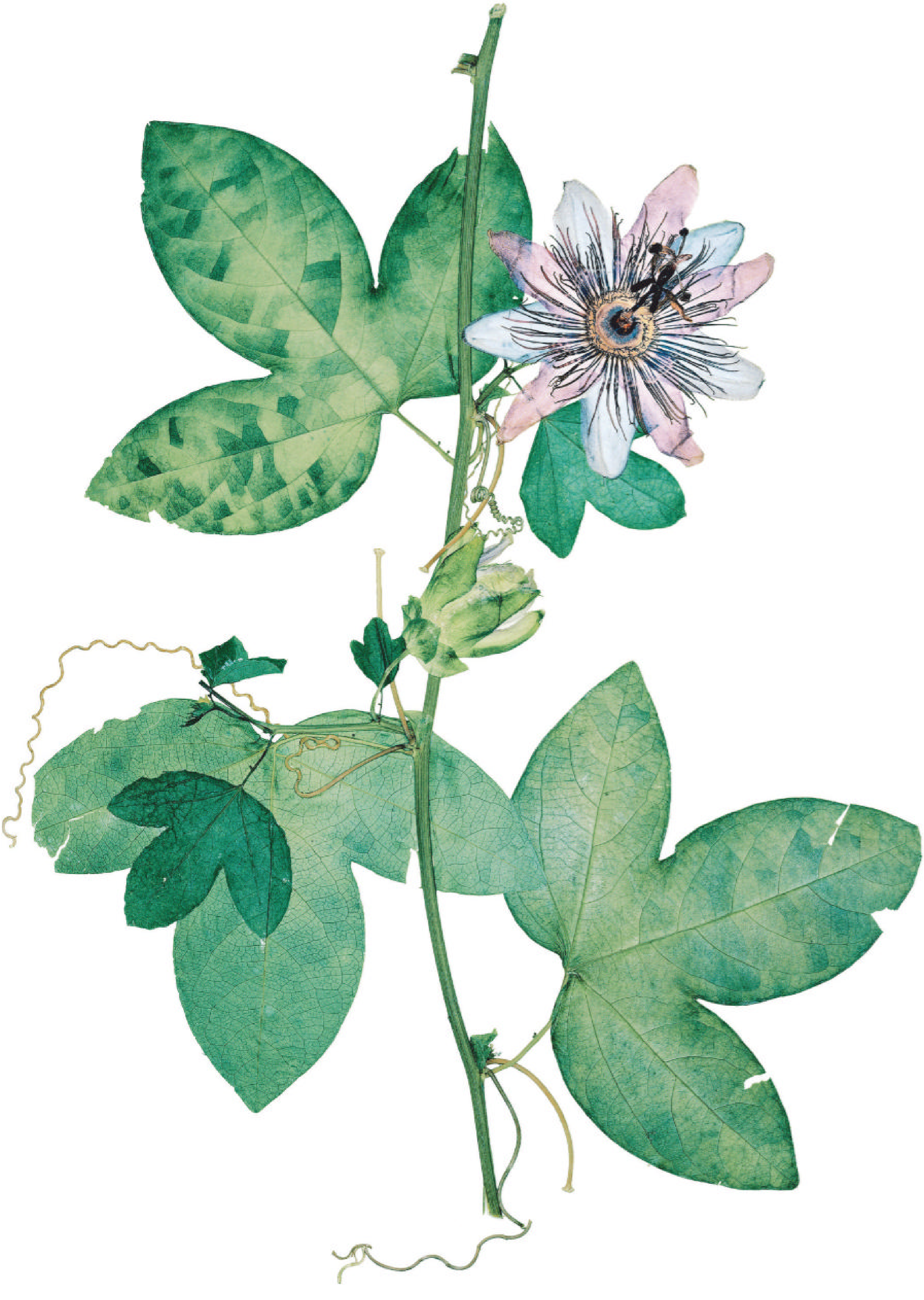
LOOKING AT THE EART ROM EVERY POSSIBLE ANGLE

NEVER OUT OF SEASON

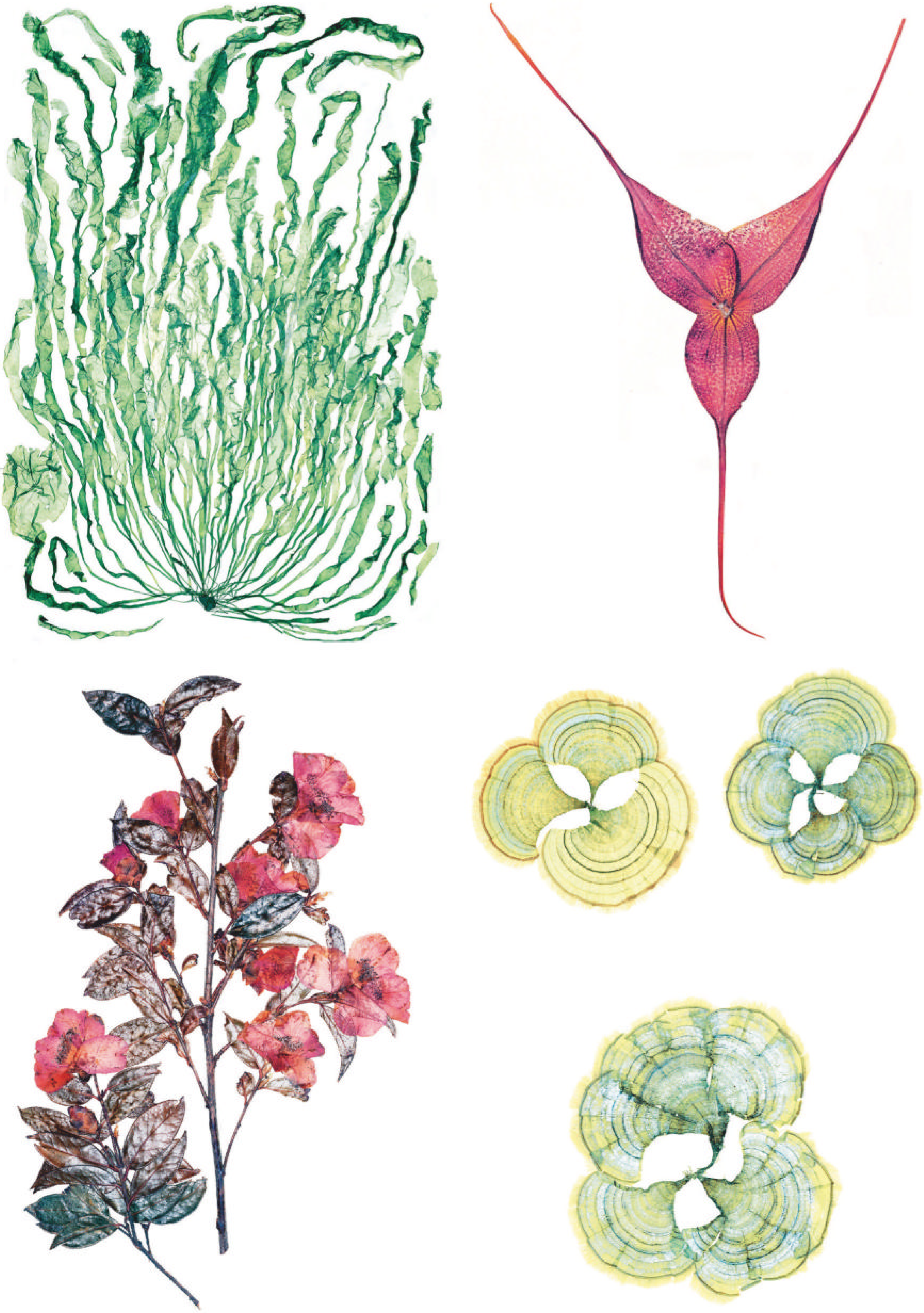
Specimens gathered over more than 300 years are carefully preserved in a London herbarium.

VOL. 239 NO. 2

A climbing lily collected in England in 1954 (left) and an *Angelica cyclocarpa* gathered from Nepal in 1975 show the lasting beauty of well-preserved plants.

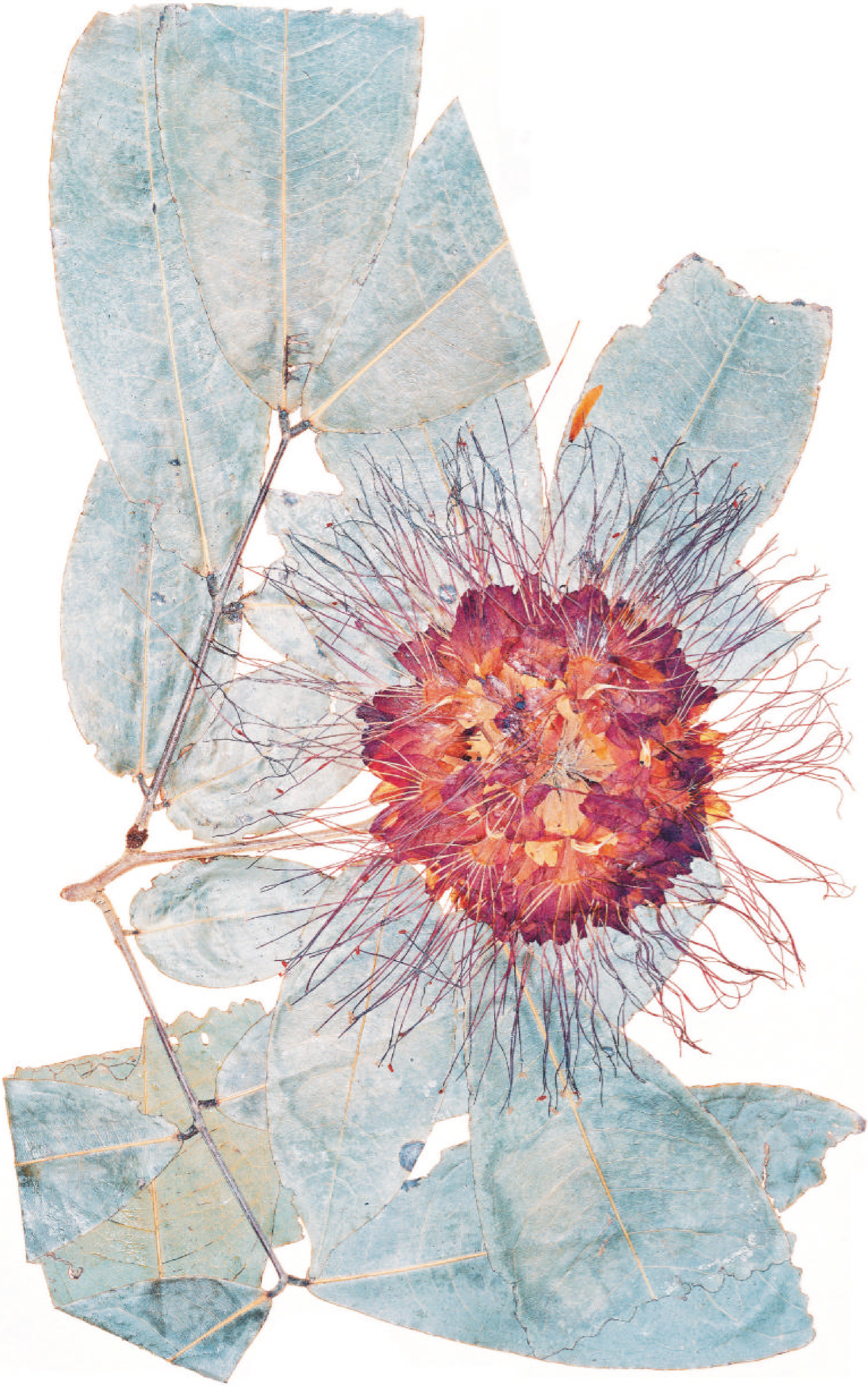


Passionflower vines have long been prized species in gardens with a temperate climate. Now housed in the Natural History Museum in London, this specimen was cultivated in New York in 1972.

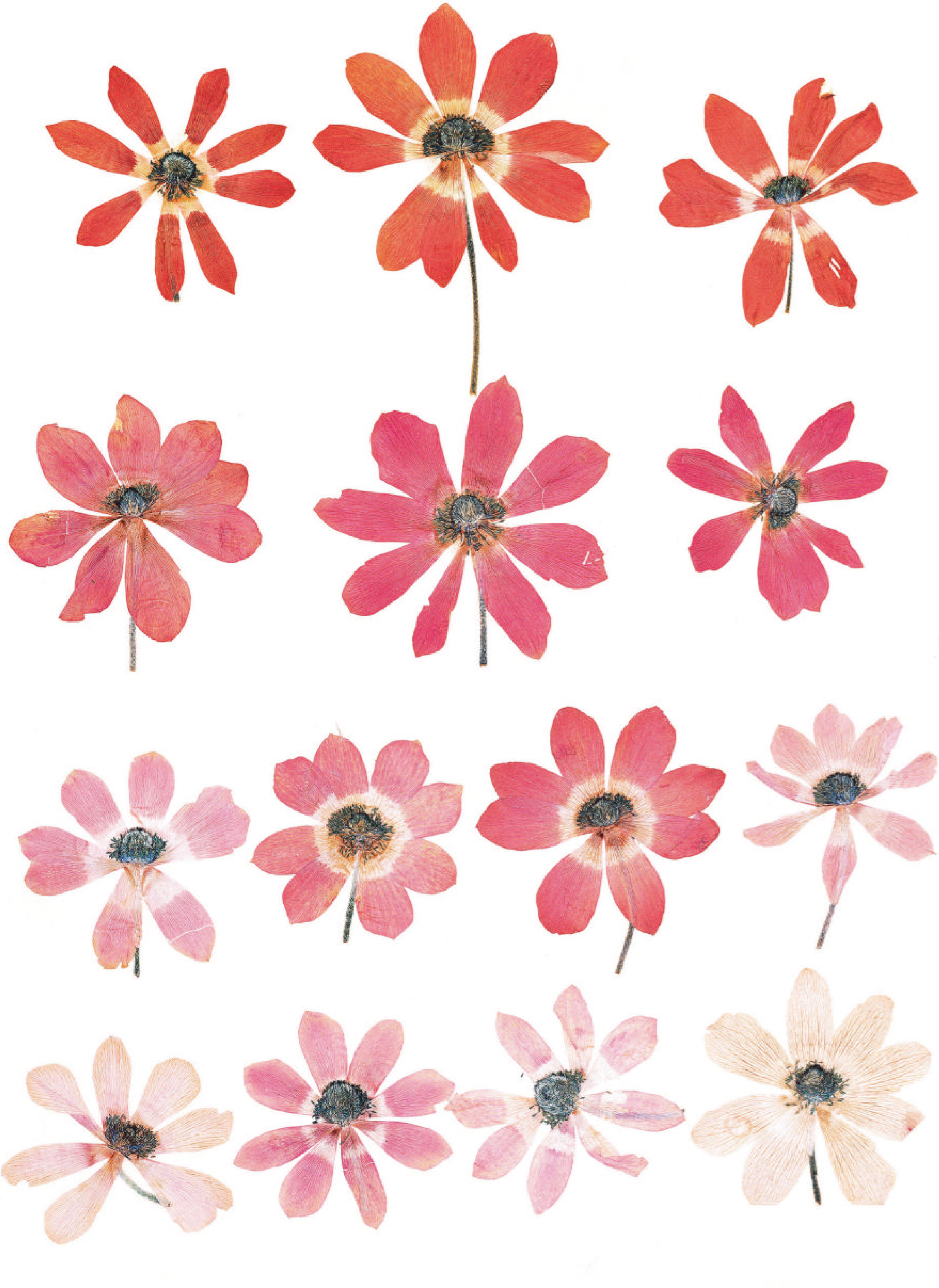


Clockwise from top left: Sea lettuce from the Isle of Man in 1895, a *dracula roezlii* orchid from Colombia in 1885, brown algae known as peacock's tail in England in 1930, and a camellia grown in England in 1979.

PROOF



In 1982 naturalists brought back to England samples of the *Brownea rosa-del-monte,* an understory tree in the Panama rainforest. Parts of the plant were said to be used for medicinal purposes.



A distinctive quality of *Anemone hortensis* is its variation of color. These anemones have petals of red, white, pink, purple, or mauve; their centers are often a uniform shade of purple.

THE BACKSTORY

AT THIS MUSEUM, PLANTS FROM AROUND THE GLOBE HAVE BEEN COLLECTED, PRESERVED—AND NOW PHOTOGRAPHED.

THE HERBARIUM at the Natural History Museum in London is one of the world's biggest plant collections. Specimens gathered over more than 300 years were dried and then glued to paper in large albums, each one now housed in its own drawer in a climate-controlled chamber.

Many samples are relics of a world that once was, brought back by famous scientists such as Carl Linnaeus. At the height of the British Empire, plants were collected for scientific, medical, and economic purposes.

For years, photographer Nick Knight leafed through the herbarium's pages, looking for specimens that were visually appealing. He estimates that he and his wife, Charlotte, flipped through thousands of drab, brown samples before finding vibrant ones—a water lily, a camellia.

Knight photographed hundreds of specimens in a tiny studio he built in the museum. Then in post-processing, he removed the original written notes and other details, giving the plants the appearance of floating. All that's left to see is nature's fine art, grown in the past and captured for posterity.

—DANIEL STONE

A biologist collected branches of this elegant shrub from Belize in 1966.

For adults with type 2 diabetes (T2D), along with diet and exercise, once-daily RYBELSUS® can help lower blood sugar

Wake Up to the Possibilities of Reaching Your A1C Goal

RYBELSUS® is proven to lower blood sugar and A1C

In a 6-month study of people with an average starting A1C of 8%, the majority of **people taking RYBELSUS® reached an A1C of less than 7%**[a]:

- Nearly 7 out of 10 people on 7 mg of RYBELSUS®
- Nearly 8 out of 10 people on 14 mg of RYBELSUS®
- About 3 out of 10 people on a sugar pill

RYBELSUS® may help you lose some weight

While not for weight loss, in the same 6-month study, people with an average starting weight of 195 pounds **lost up to 8 pounds**[a]:

- 5 pounds on 7 mg of RYBELSUS®
- 8 pounds on 14 mg of RYBELSUS®
- 3 pounds on a sugar pill

While many people in medical studies lost weight, some did gain weight.

RYBELSUS® does not increase the risk of major cardiovascular (CV) events such as heart attack, stroke, or death[b]

[a] In a 6-month study looking at A1C with 703 adults with T2D comparing 7 mg RYBELSUS® and 14 mg RYBELSUS® with a sugar pill when both were added to diet and exercise.

[b] In a cardiovascular safety study, 3183 adults with T2D and a high risk of CV events were treated with either 14 mg RYBELSUS® or a sugar pill in addition to their usual diabetes and CV medications.

If eligible, **you may pay as little as $10 for a 30-day prescription**[c]

Text[d] **RESULTS to 44535** to learn more about RYBELSUS®

What is Rybelsus®?

Rybelsus® (semaglutide) tablets 7 mg or 14 mg is a prescription medicine for adults with type 2 diabetes that along with diet and exercise may improve blood sugar (glucose).

- Rybelsus® is not recommended as the first choice of medicine for treating diabetes
- It is not known if Rybelsus® can be used in people who have had pancreatitis
- Rybelsus® is not for use in people with type 1 diabetes and people with diabetic ketoacidosis
- It is not known if Rybelsus® is safe and effective for use in children under 18 years of age

Important Safety Information

What is the most important information I should know about Rybelsus®?

Rybelsus® may cause serious side effects, including:

- **Possible thyroid tumors, including cancer.** Tell your healthcare provider if you get a lump or swelling in your neck, hoarseness, trouble swallowing, or shortness of breath. These may be symptoms of thyroid cancer. In studies with rodents, Rybelsus® and medicines that work like Rybelsus® caused thyroid tumors, including thyroid cancer. It is not known if Rybelsus® will cause thyroid tumors or a type of thyroid cancer called medullary thyroid carcinoma (MTC) in people

Do not use Rybelsus® if:

- you or any of your family have ever had MTC, or if you have an endocrine system condition called Multiple Endocrine Neoplasia syndrome type 2 (MEN 2)
- you are allergic to semaglutide or any of the ingredients in Rybelsus®

Before using Rybelsus®, tell your healthcare provider if you have any other medical conditions, including if you:

- have or have had problems with your pancreas or kidneys
- have a history of vision problems related to your diabetes
- are pregnant or plan to become pregnant. It is not known if Rybelsus® will harm your unborn baby. You should stop using Rybelsus® 2 months before you plan to become pregnant. Talk to your healthcare provider about the best way to control your blood sugar if you plan to become pregnant or while you are pregnant
- are breastfeeding or plan to breastfeed. Breastfeeding is not recommended during treatment with Rybelsus®

Tell your healthcare provider about all the medicines you take, including prescription and over-the-counter medicines, vitamins, and herbal supplements. Rybelsus® may affect the way some medicines work and some medicines may affect the way Rybelsus® works.

What are the possible side effects of Rybelsus®?

Rybelsus® may cause serious side effects, including:

- **inflammation of your pancreas (pancreatitis).** Stop using Rybelsus® and call your healthcare provider right away if you have severe pain in your stomach area (abdomen) that will not go away, with or without vomiting. You may feel the pain from your abdomen to your back
- **changes in vision.** Tell your healthcare provider if you have changes in vision during treatment with Rybelsus®
- **low blood sugar (hypoglycemia).** Your risk for getting low blood sugar may be higher if you use Rybelsus® with another medicine that can cause low blood sugar, such as a sulfonylurea or insulin. **Signs and symptoms of low blood sugar may include:** dizziness or lightheadedness, blurred vision, anxiety, irritability or mood changes, sweating, slurred speech, hunger, confusion or drowsiness, shakiness, weakness, headache, fast heartbeat, and feeling jittery
- **kidney problems (kidney failure).** In people who have kidney problems, diarrhea, nausea, and vomiting may cause a loss of fluids (dehydration), which may cause kidney problems to get worse. It is important for you to drink fluids to help reduce your chance of dehydration
- **serious allergic reactions.** Stop using Rybelsus® and get medical help right away, if you have any symptoms of a serious allergic reaction including itching, rash, or difficulty breathing

The most common side effects of Rybelsus® may include nausea, stomach (abdominal) pain, diarrhea, decreased appetite, vomiting, and constipation. Nausea, vomiting, and diarrhea are most common when you first start Rybelsus®.

Please see Brief Summary of Prescribing Information on adjacent page.

[c] Commercially insured patients only. Offer valid for up to six 30-day fills. Eligibility and other restrictions apply.

[d] Message and data rates may apply. Check with your mobile service provider. Message frequency will be based on your selections. Text **HELP** to **44535** for help. Text **STOP** to **44535** to quit. See Terms and Conditions of Use at RYBELSUS.com.

See cost and savings info at RYBELSUS.com, and ask your healthcare provider about RYBELSUS® today.

novo nordisk®

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RYBELSUS®
semaglutide tablets 7mg | 14mg

Brief Summary of information about RYBELSUS® (semaglutide) tablets

RYBELSUS®
semaglutide tablets 7mg | 14mg

Rx Only

This information is not comprehensive.

- Talk to your healthcare provider or pharmacist
- Visit www.novo-pi.com/rybelsus.pdf to obtain the FDA-approved product labeling
- Call 1-833-GLP-PILL

Read this Medication Guide before you start using RYBELSUS® and each time you get a refill. There may be new information. This information does not take the place of talking to your healthcare provider about your medical condition or your treatment.

What is the most important information I should know about RYBELSUS®?

RYBELSUS® may cause serious side effects, including:

- **Possible thyroid tumors, including cancer.** Tell your healthcare provider if you get a lump or swelling in your neck, hoarseness, trouble swallowing, or shortness of breath. These may be symptoms of thyroid cancer. In studies with rodents, RYBELSUS® and medicines that work like RYBELSUS® caused thyroid tumors, including thyroid cancer. It is not known if RYBELSUS® will cause thyroid tumors or a type of thyroid cancer called medullary thyroid carcinoma (MTC) in people.
- Do not use RYBELSUS® if you or any of your family have ever had a type of thyroid cancer called medullary thyroid carcinoma (MTC), or if you have an endocrine system condition called Multiple Endocrine Neoplasia syndrome type 2 (MEN 2).

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RYBELSUS® is a prescription medicine used along with diet and exercise to improve blood sugar (glucose) in adults with type 2 diabetes.

- RYBELSUS® is not recommended as the first choice of medicine for treating diabetes.
- It is not known if RYBELSUS® can be used in people who have had pancreatitis.
- RYBELSUS® is not for use in patients with type 1 diabetes and people with diabetic ketoacidosis.

It is not known if RYBELSUS® is safe and effective for use in children under 18 years of age.

Do not use RYBELSUS® if:

- you or any of your family have ever had a type of thyroid cancer called medullary thyroid carcinoma (MTC) or if you have an endocrine system condition called Multiple Endocrine Neoplasia syndrome type 2 (MEN 2).
- you are allergic to semaglutide or any of the ingredients in RYBELSUS®.

Before using RYBELSUS®, tell your healthcare provider if you have any other medical conditions, including if you:

- have or have had problems with your pancreas or kidneys.
- have a history of vision problems related to your diabetes.
- are pregnant or plan to become pregnant. It is not known if RYBELSUS® will harm your unborn baby. You should stop using RYBELSUS® 2 months before you plan to become pregnant. Talk to your healthcare provider about the best way to control your blood sugar if you plan to become pregnant or while you are pregnant.
- are breastfeeding or plan to breastfeed. Breastfeeding is not recommended during treatment with RYBELSUS®.

Tell your healthcare provider about all the medicines you take, including prescription and over-the-counter medicines, vitamins, and herbal supplements. RYBELSUS® may affect the way some medicines work and some medicines may affect the way RYBELSUS® works.

Before using RYBELSUS®, talk to your healthcare provider about low blood sugar and how to manage it. Tell your healthcare provider if you are taking other medicines to treat diabetes, including insulin or sulfonylureas.

Know the medicines you take. Keep a list of them to show your healthcare provider and pharmacist when you get a new medicine.

How should I take RYBELSUS®?

- Take RYBELSUS® exactly as your healthcare provider tells you to.
- Take RYBELSUS® by mouth on an empty stomach when you first wake up.
- Take RYBELSUS® with a sip of water (no more than 4 ounces).
- Do not split, crush or chew. Swallow RYBELSUS® whole.
- After 30 minutes, you can eat, drink, or take other oral medications. RYBELSUS® works best if you eat 30 to 60 minutes after taking RYBELSUS®.
- If you miss a dose of RYBELSUS®, skip the missed dose and go back to your regular schedule.
- Talk to your healthcare provider about how to prevent, recognize and manage low blood sugar (hypoglycemia), high blood sugar (hyperglycemia), and problems you have because of your diabetes.

What are the possible side effects of RYBELSUS®?

RYBELSUS® may cause serious side effects, including:

- **See "What is the most important information I should know about RYBELSUS®?"**
- **inflammation of your pancreas (pancreatitis).** Stop using RYBELSUS® and call your healthcare provider right away if you have severe pain in your stomach area (abdomen) that will not go away, with or without vomiting. You may feel the pain from your abdomen to your back.
- **changes in vision.** Tell your healthcare provider if you have changes in vision during treatment with RYBELSUS®.
- **low blood sugar (hypoglycemia).** Your risk for getting low blood sugar may be higher if you use RYBELSUS® with another medicine that can cause low blood sugar, such as a sulfonylurea or insulin. **Signs and symptoms of low blood sugar may include:**
  - dizziness or light-headedness
  - anxiety, irritability, or mood changes
  - slurred speech
  - shakiness
  - fast heartbeat
  - hunger
  - weakness
  - feeling jittery
  - blurred vision
  - sweating
  - confusion or drowsiness
  - headache
- **kidney problems (kidney failure).** In people who have kidney problems, diarrhea, nausea, and vomiting may cause a loss of fluids (dehydration) which may cause kidney problems to get worse. It is important for you to drink fluids to help reduce your chance of dehydration.
- **serious allergic reactions.** Stop using RYBELSUS® and get medical help right away, if you have any symptoms of a serious allergic reaction including itching, rash, or difficulty breathing.

The most common side effects of RYBELSUS® may include nausea, stomach (abdominal) pain, diarrhea, decreased appetite, vomiting and constipation. Nausea, vomiting and diarrhea are most common when you first start RYBELSUS®.

Talk to your healthcare provider about any side effect that bothers you or does not go away. These are not all the possible side effects of RYBELSUS®.

Call your doctor for medical advice about side effects. You may report side effects to FDA at 1-800-FDA-1088.

How should I store RYBELSUS®?

- Store RYBELSUS® at room temperature between 68°F and 77°F (20°C to 25°C).
- Store in a dry place away from moisture.
- Store tablet in the original pack.
- Keep the tablet in the pack until you are ready to take it.
- **Keep RYBELSUS® and all medicines out of the reach of children.**

Revised: 01/2020

Manufactured by: Novo Nordisk A/S, DK-2880
Bagsvaerd, Denmark

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US20RYB00618 2/2020

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EXPLORE

IN THIS SECTION

How Moths Weather Rain
A New Loo for Astronauts
Volcanic Lightning
The Craft of Clock Repair

ILLUMINATING THE MYSTERIES—AND WONDERS—ALL AROUND US EVERY DAY

NATIONAL GEOGRAPHIC
VOL. 238 NO. 2

Are We Born to Wander?

TRAVELING IS NOT A RATIONAL ACTIVITY, BUT IT'S IN OUR GENES. HERE'S WHY YOU SHOULD START PLANNING A TRIP NOW.

BY **ERIC WEINER**

I'VE BEEN PUTTING MY PASSPORT to good use lately. I use it as a coaster and to level wobbly table legs. It makes an excellent cat toy.

Welcome to the pandemic of disappointments. Canceled trips, or ones never planned lest they be canceled. Family reunions, study-abroad years, lazy beach vacations. Poof. Gone. Obliterated by a tiny virus and the long list of countries where United States passports are not welcome.

It is not natural for us to be this sedentary. Travel is in our genes. For most of the time our species has existed, "we've lived as nomadic hunter-gatherers moving about in small bands of 150 or fewer people," writes Christopher Ryan in *Civilized to Death*. This nomadic life was no accident. It was useful. "Moving to a neighboring band is always an option to avoid brewing conflict or just for a change in social scenery," says Ryan. Robert Louis Stevenson put it more succinctly: "The great affair is to move."

HOPE LIES IN THE VERY NATURE OF TRAVEL. TRAVEL ENTAILS WISHFUL THINKING. IT DEMANDS A LEAP OF FAITH, AND OF IMAGINATION, TO BOARD A PLANE FOR SOME FARAWAY LAND.

What if we can't move, though? What if we're unable to hunt or gather? What's a traveler to do? There are many ways to answer that question. "Despair," though, is not one of them.

We are an adaptive species. We can tolerate brief periods of forced sedentariness. A dash of self-delusion helps. We're not grounded, we tell ourselves. We're merely between trips, like the unemployed salesman between opportunities. We pass the days thumbing through old travel journals and Instagram feeds. We gaze at souvenirs. All this helps. For a while.

The travel industry is hurting, and so are travelers. "I dwelled so much on my disappointment that it almost physically hurt," Paris-based journalist Joelle Diderich told me, after having to cancel five trips last spring alone.

My friend James Hopkins is a Buddhist living in Kathmandu, Nepal. You'd think he'd thrive during the lockdown, a sort of mandatory meditation retreat. For a while he did.

But during a recent Skype call, James looked haggard and dejected. He was growing restless, he confessed, and longed "for the old 10-countries-a-year schedule." Nothing seemed to help, he told me. "No matter how many candles I lit, or how much incense I burned, and in spite of living in one of the most sacred places in South Asia, I just couldn't change my habits."

When we ended our call, I felt relieved, my grumpiness validated. It's not me; it's the pandemic. But I also worried. If a Buddhist in Kathmandu is going nuts, what hope do the rest of us stilled souls have?

I think hope lies in the very nature of travel. Travel entails wishful thinking. It demands a leap of faith, and of imagination, to board a plane for some faraway land, hoping, wishing, for a taste of the ineffable. Travel is one of the few activities we engage in not knowing the outcome and reveling in that uncertainty. Nothing is more forgettable than the trip that goes exactly as planned.

TRAVEL IS NOT A RATIONAL ACTIVITY. It makes no sense to squeeze yourself into an alleged seat only to be hurled at frightening speed to a distant place where you don't speak the language or know the customs. All at great expense. If we stopped to do the cost-benefit analysis, we'd never go anywhere. Yet we do.

The geologic formations at South Dakota's Badlands National Park can inspire "a new way of looking at things," which, writer Henry Miller observed, is among the rewards of travel.

PHOTO: BENJAMIN RASMUSSEN

That's one reason why I'm bullish on travel's future. In fact, I'd argue travel is an essential industry, an essential activity. It's not essential the way hospitals and grocery stores are essential. Travel is essential the way books and hugs are essential. Food for the soul. Right now, we're between courses, savoring where we've been, anticipating where we'll go. Maybe it's Zanzibar and maybe it's the campground down the road that you've always wanted to visit.

James Oglethorpe, a seasoned traveler, is happy to sit still for a while and gaze at "the slow change of light and clouds on the Blue Ridge Mountains" in Virginia, where he lives. "My mind can take me the rest of the way around this world and beyond it."

It's not the place that is special but what we bring to it and, crucially, how we interact with it. Travel is not about the destination or the journey. It's about stumbling across "a new way of looking at things," as writer Henry Miller observed. We need not travel far to gain a fresh perspective.

No one knew this better than Henry David Thoreau, who lived nearly all of his too-short life in Concord, Massachusetts. There he observed Walden Pond from every conceivable vantage point: from a hilltop, on its shores, under the water. Sometimes he'd even bend over and peer through his legs, marveling at the inverted world. "From the right point of view, every storm and every drop in it is a rainbow," he wrote.

Thoreau never tired of gazing at his beloved pond, nor have we outgrown the quiet beauty of our frumpy, analog world. If anything, the pandemic has rekindled our affection for it. We've seen what an atomized, digital existence looks like, and we (most of us anyway) don't care for it. The bleachers at Chicago's Wrigley Field; the orchestra section at New York City's Lincoln Center; the alleyways of Tokyo. We miss these places. We are creatures of place, and always will be.

After the attacks of September 11, many predicted the end of air travel, or at least a dramatic reduction. Yet the airlines rebounded steadily and by 2017 flew a record four billion passengers. Briefly deprived of the miracle of flight, we appreciated it more and today tolerate the inconvenience of body scans and pat downs for the privilege of transporting our flesh-and-bone selves to far-flung locations, where we break bread with other incarnate beings.

> TRAVEL IS FOOD FOR THE SOUL. RIGHT NOW, WE'RE BETWEEN COURSES, SAVORING WHERE WE'VE BEEN, ANTICIPATING WHERE WE'LL GO.

In our rush to return to the world, we should be mindful of the impact of mass tourism on the planet. Now is the time to embrace the fundamental values of sustainable tourism and let them guide your future journeys. Go off the beaten path. Linger longer in destinations. Travel in the off-season. Connect with communities and spend your money in ways that support locals. Consider purchasing carbon offsets. And remember that the whole point of getting out there is to embrace the differences that make the world so colorful. "One of the great benefits of travel is meeting new people and coming into contact with different points of view," says Pauline Frommer, travel expert and radio host.

So go ahead and plan that trip. It's good for you, say researchers such as Matthew Killingsworth, a senior fellow at the University of Pennsylvania's Wharton School. "Our future-mindedness can be a source of joy if we know good things are coming, and travel is an especially good thing to have to look forward to," he told *National Geographic* last year. Plotting a trip is nearly as enjoyable as actually taking one. Anticipation is its own reward.

I've witnessed firsthand the frisson of anticipatory travel. My wife, not usually a fan of travel photos, now spends hours on Instagram gazing at images of Alpine lodges and Balinese rice fields. "What's going on?" I asked one day. "They're just absolutely captivating," she replied. "They make me remember that there is a big, beautiful world out there."

Many of us, me included, have taken travel for granted. We grew lazy and entitled, and that is never good. Tom Swick, a travel writer, tells me he used to view travel as a given. Now, he says, "I look forward to experiencing it as a gift." □

Eric Weiner is a former foreign correspondent for NPR and the best-selling author of books including *The Geography of Bliss*, *The Geography of Genius*, and *The Socrates Express*.

Sustainable Futures

As travel normalizes, some destinations will be better prepared to manage the problems of tourism. Heritage preservation and conservation efforts are among the solutions adopted by the 25 places in our annual Best of the World feature: *natgeo.com/bestoftheworld*. Here are some highlights.

Denver, Colorado	Powering toward 100 percent renewable electricity by 2030
Alonissos, Greece	Preserving an ancient shipwreck in a new underwater museum
Gabon	Safeguarding more than 11 percent of the country as national parkland
Copenhagen, Denmark	Aiming to be the world's first carbon-neutral capital by 2025
British Columbia, Canada	Focusing on Indigenous travel experiences hosted by First Nations
Lord Howe Island, Australia	Enlisting technology and community volunteers to protect endemic species

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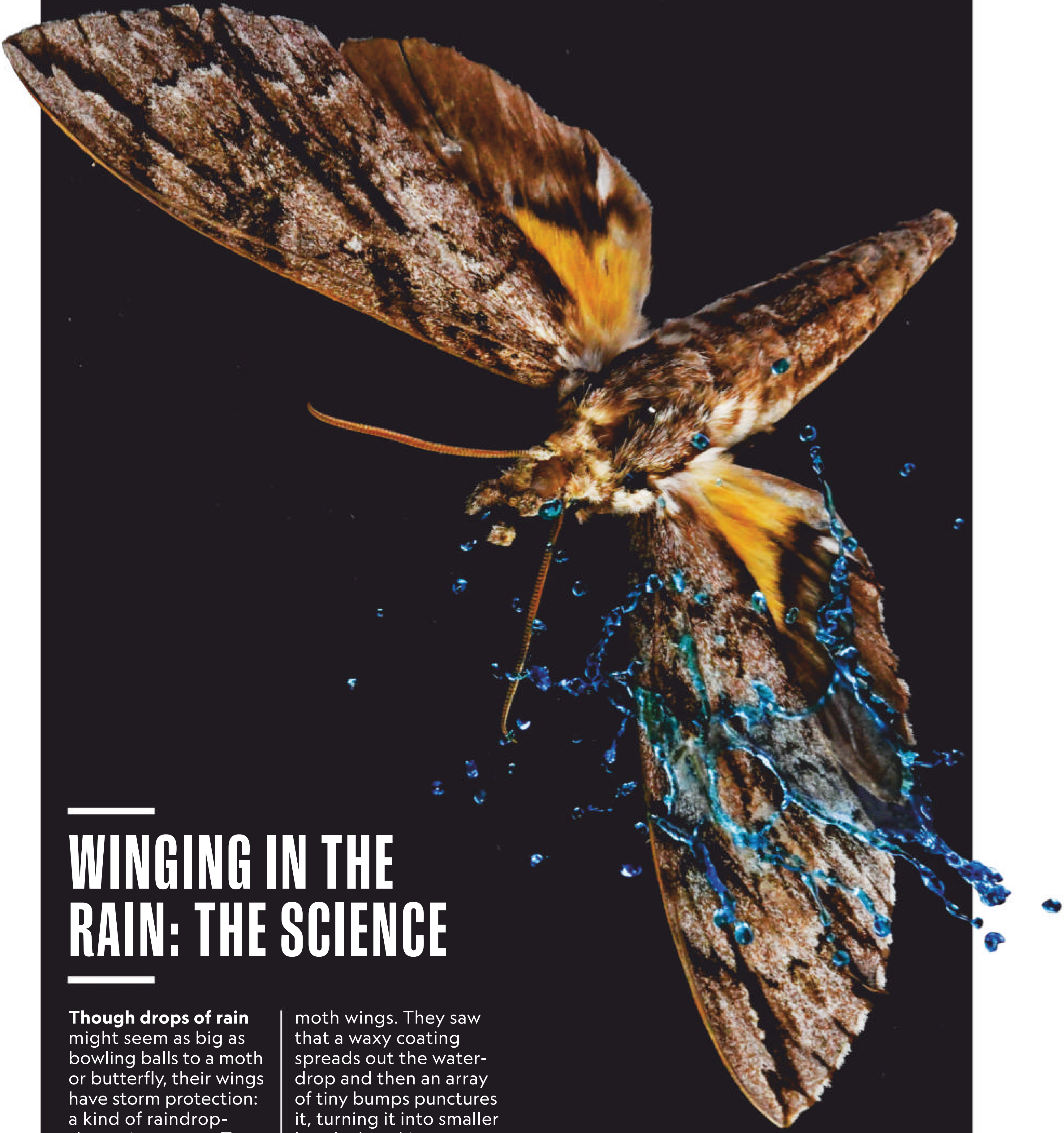

WINGING IN THE RAIN: THE SCIENCE

Though drops of rain might seem as big as bowling balls to a moth or butterfly, their wings have storm protection: a kind of raindrop-shattering armor. To study the "superhydrophobic" surface, Cornell University scientists took high-speed images of waterdrops striking moth wings. They saw that a waxy coating spreads out the waterdrop and then an array of tiny bumps punctures it, turning it into smaller beads that skitter away. Mimicking that defense system might produce better water-repellent substances, researchers say. —MAYA WEI-HAAS

PHOTO: BRIAN WU, SEUNGHO KIM, JASON DOMBROSKIE, AND SUNGHWAN JUNG

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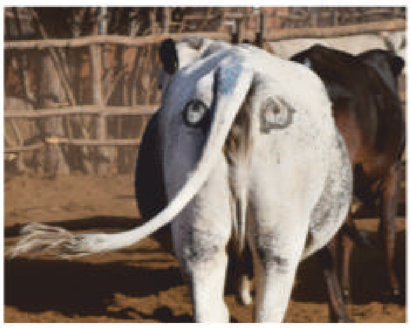
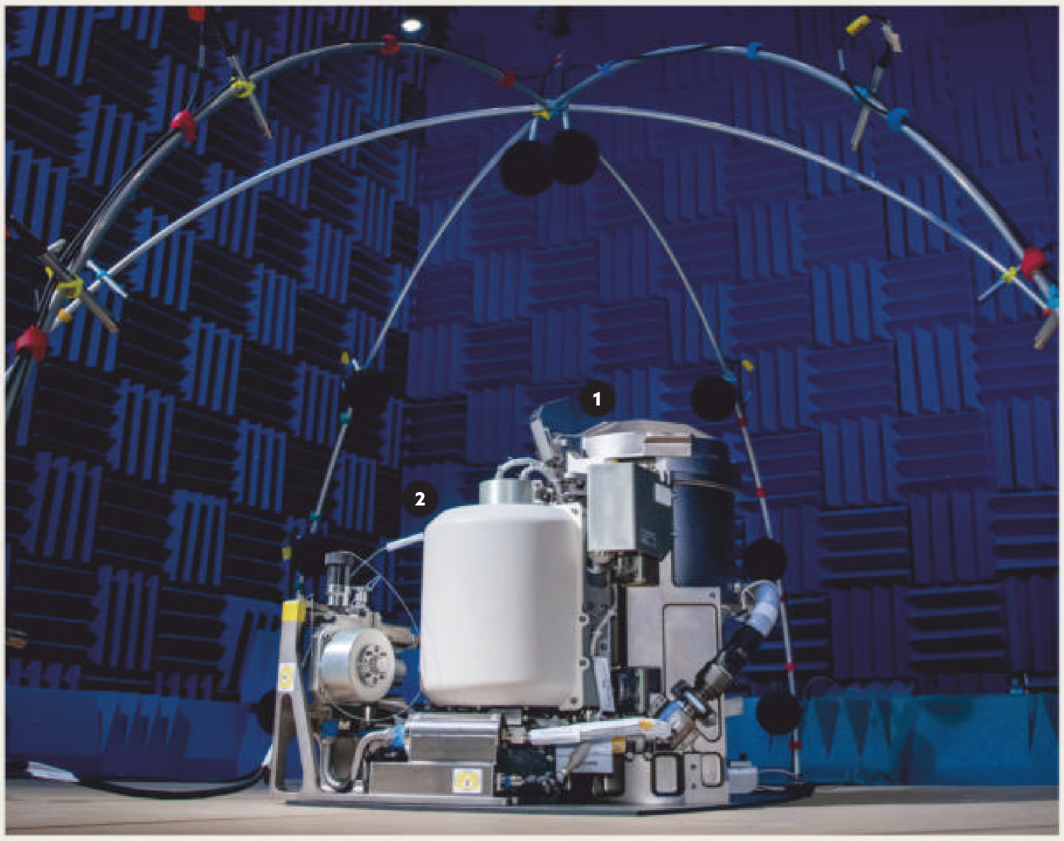
DISPATCHES
FROM THE FRONT LINES
OF SCIENCE
AND INNOVATION

They're Not Real Eyes, But ...

Big cats may give up the hunt if they think they've been spotted, so some Botswana ranchers try to deter the predators by painting eyes on their cattle's bums. A four-year study found that cattle with this paint job were less likely to be killed by leopards and lions than those without it. —AR





Key elements of NASA's new commode include **(1)** the seat, and **(2)** the tank that preps urine for recycling to potable water. (Or as astronaut Jessica Meir puts it: "Today's coffee is tomorrow's coffee!")

SPACE TRAVEL

AMENITIES, IMPROVED

NASA REDESIGNED THIS SPACE TOILET TO WORK BETTER, ESPECIALLY FOR WOMEN ASTRONAUTS.

IN SPACE, PROPERLY DEPOSITING human waste can be tricky. The lack of gravity can result in excretory anomalies, as ground control overheard during NASA's 1969 Apollo 10 mission: "Give me a napkin quick," Tom Stafford implored fellow astronauts. "There's a turd floating through the air." Now, for the first time since 1993, NASA has sent a brand-new, redesigned toilet to the International Space Station. Like its predecessor, the fancier throne uses suction to whisk away waste. Astronauts urinate into a handheld funnel and hose, and deposit the solid stuff exactly as you'd expect. But with more women visiting space, the new loo's seat was fashioned with female anatomy in mind. It allows women to more easily multitask—or perform what NASA refers to as "dual ops"—and the seat plus handrails provides options on approach. "Some of the crew like to hover over the seat, some crew like to firmly dock," says NASA's Melissa McKinley. "The main thing is you want the [seat] shape to guide you into the proper location." A bonus of the new design: Lifting the lid automatically turns on the toilet's suction, the better to prevent rogue floaters. —NADIA DRAKE

ECOSYSTEMS

Dig This: One More Talent of Lyrebirds

The superb lyrebird can crush scorpions with its rakelike feet. It can mimic sounds, from car alarms to human speech. And, a new study suggests, the multitalented bird turns over more soil than any other animal on land, even earthworms and gophers. Scouring the forest floor for insects, each bird can kick up a whopping 388 tons of leaf litter and earth a year across its range in eastern Australia. That beneficially aerates soils and reduces fire risk. —ANNIE ROTH

PHOTOS (FROM TOP): BEN YEXLEY; JAMES BLAIR, NASA/JSC; JOEL SARTORE, PHOTO ARK

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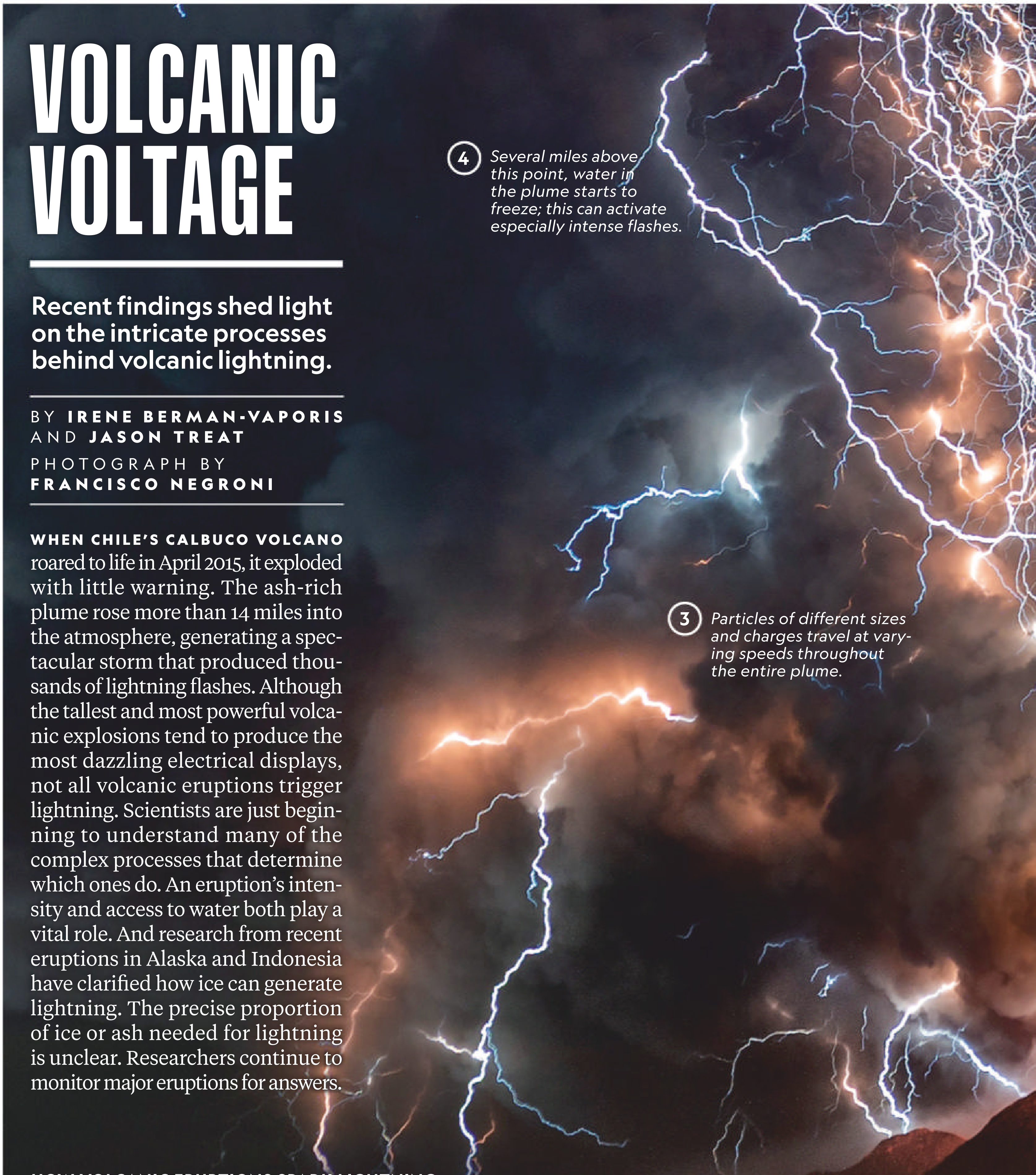
VOLCANIC VOLTAGE

Recent findings shed light on the intricate processes behind volcanic lightning.

BY **IRENE BERMAN-VAPORIS** AND **JASON TREAT**

PHOTOGRAPH BY **FRANCISCO NEGRONI**

WHEN CHILE'S CALBUCO VOLCANO roared to life in April 2015, it exploded with little warning. The ash-rich plume rose more than 14 miles into the atmosphere, generating a spectacular storm that produced thousands of lightning flashes. Although the tallest and most powerful volcanic explosions tend to produce the most dazzling electrical displays, not all volcanic eruptions trigger lightning. Scientists are just beginning to understand many of the complex processes that determine which ones do. An eruption's intensity and access to water both play a vital role. And research from recent eruptions in Alaska and Indonesia have clarified how ice can generate lightning. The precise proportion of ice or ash needed for lightning is unclear. Researchers continue to monitor major eruptions for answers.



④ *Several miles above this point, water in the plume starts to freeze; this can activate especially intense flashes.*

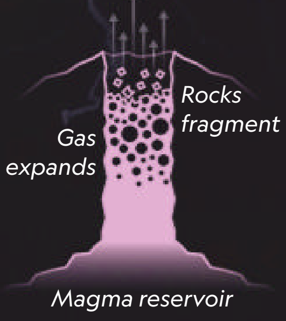
③ *Particles of different sizes and charges travel at varying speeds throughout the entire plume.*

HOW VOLCANIC ERUPTIONS SPARK LIGHTNING

1

Magma breaks up

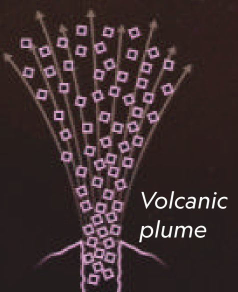
As magma rises toward the volcano's surface, its water rapidly turns to vapor, which shatters the molten rock into tiny particles. This creates charged particles during the earliest stage of an eruption.



2

Particles collide

As the ash plume bursts into the atmosphere, the densely packed particles crash into one another, driven by momentum. Friction makes them gain and lose electrons and become electrically charged.

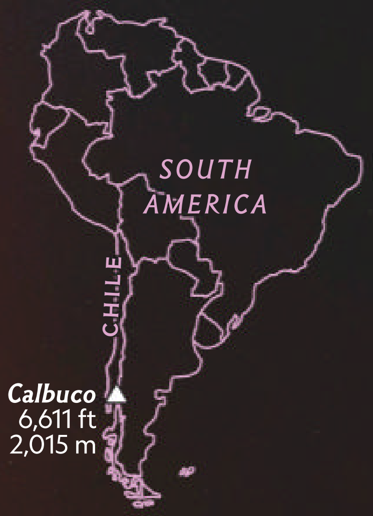


MAYA WEI-HAAS, NGM STAFF. SOURCE: ALEXA VAN EATON, U.S. GEOLOGICAL SURVEY

WHERE Los Lagos, Chile

WHEN April 2015

DISTINCTION The Calbuco volcano erupted in two primary phases in April 2015, exploding for the first time since 1972. The lightning-rich blast was captured in vivid detail by photographer Francisco Negroni.



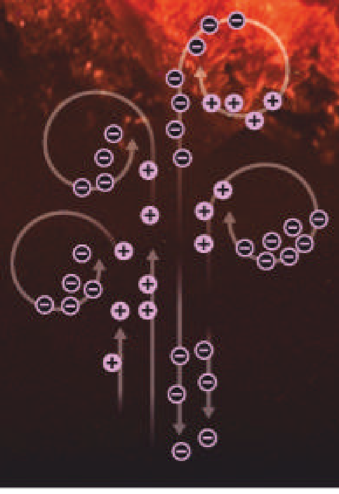
② *Collisions between rock particles, a process known as tribocharging, occur when particles scrape or bounce off each other.*

① *Near the volcanic vent, tiny electrical discharges emit a signal known as continual radio frequency, an early sign of a volcanic eruption.*

3

Charges separate

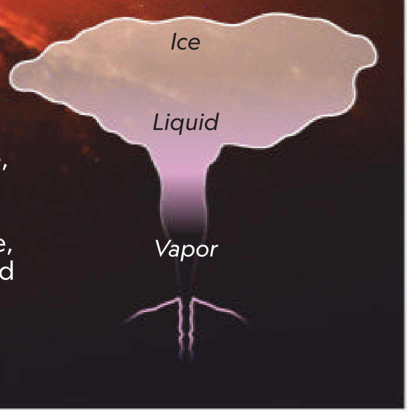
Positively charged particles begin to separate from negatively charged particles within the plume. This results in a charge imbalance that builds up an electric field strong enough to trigger flashes of lightning.



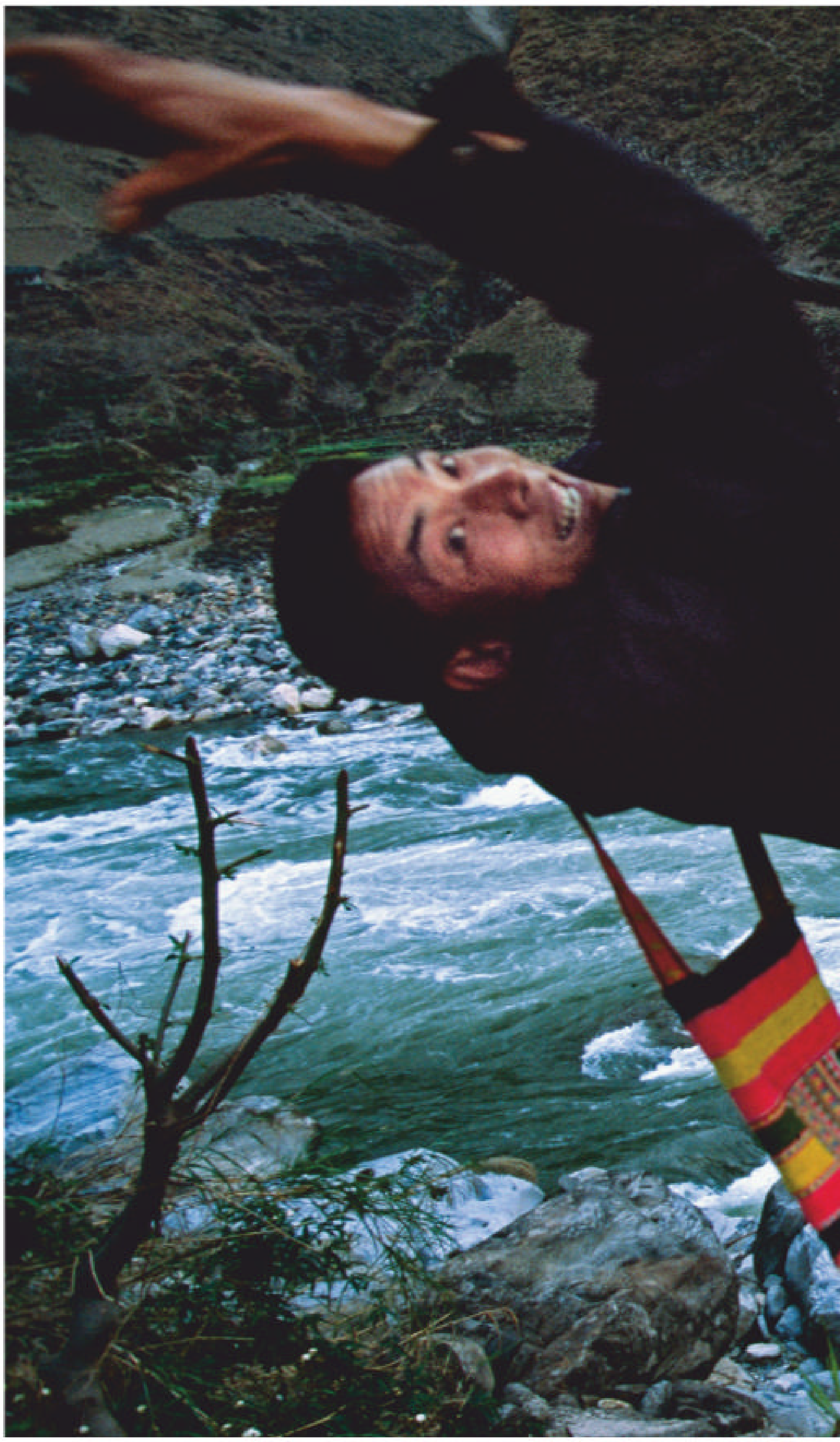
4

Water freezes

If a plume rises high enough in the atmosphere, ice will form. Water-rich plumes tend to produce more ice crystals. When ice, hail, and supercooled liquid droplets collide, lightning rates skyrocket.



A Quick Zip to Market



A PHOTOGRAPHER CHRONICLES A TRADITIONAL WAY OF LIFE BOUND BY A POWERFUL RIVER—AND THREATENED BY CHANGE.

STORY AND PHOTOGRAPH BY
FRITZ HOFFMANN

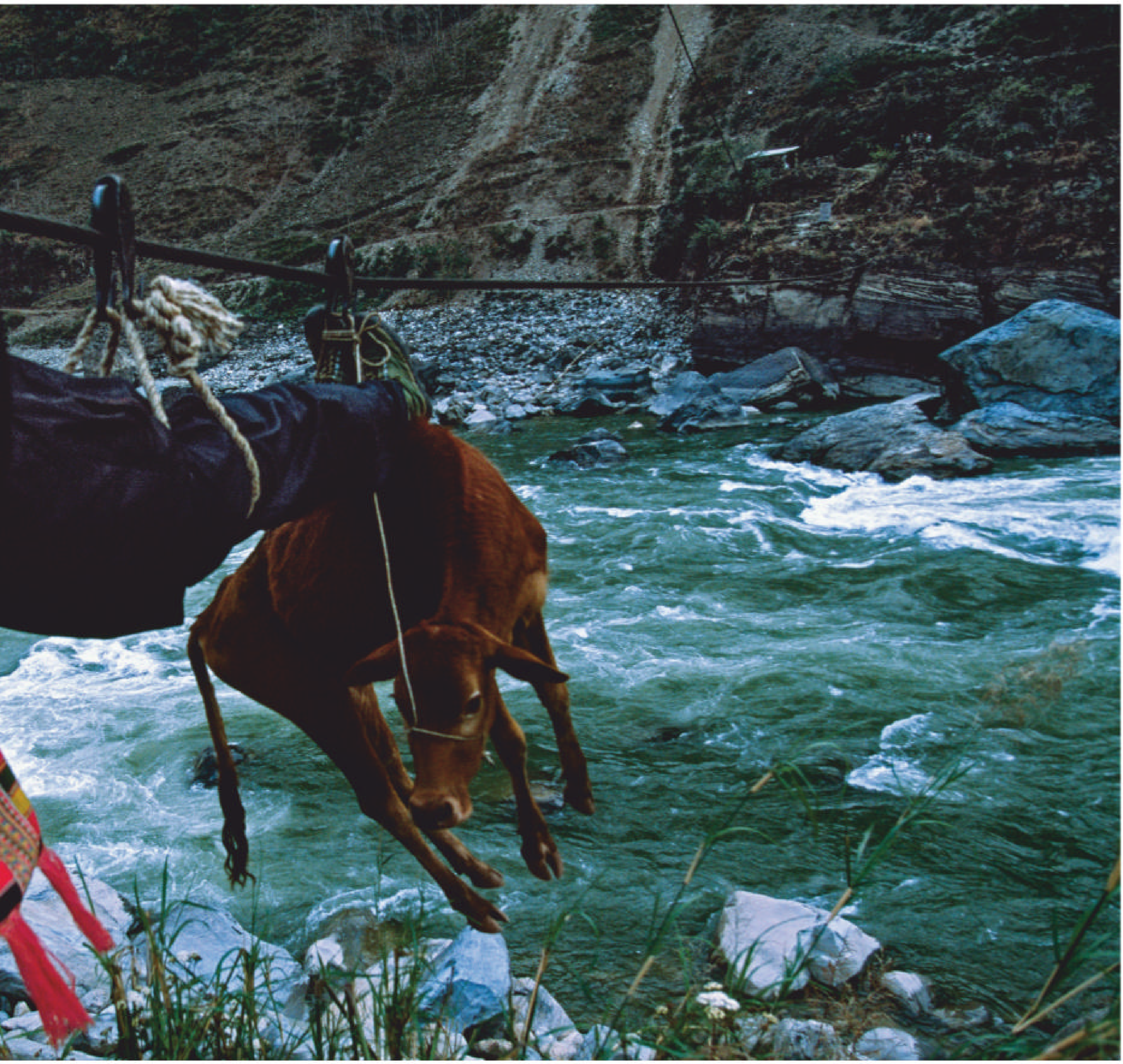
THE SALWEEN RIVER, known as the Nu in China, is one of the last great free-flowing rivers in Asia. Nearly two decades ago China announced it would dam the Nu. Multiple ethnic groups live in this part of southwestern China, which is called Three Parallel Rivers for the Nu, the Jinsha (Yangtze), and the Lancang (Mekong) Rivers that flow through it and has been named a UNESCO World Heritage site for its rich biodiversity. In 2008 I traveled there to tell the story of this remote region before it was permanently altered.

I found that there was very little bottomland along the Nu. Villages hid high above the steep walls of the river's gorge; a road clung to one side. Few bridges spanned the river. I saw locals crossing by zip line, thick steel cables attached to the sides of the ravine, one for each direction. People carried a rope and pulley looped to their belt or slung over their shoulder, ready to hitch to the cables and zip across.

While photographing the area, I mapped the locations of all the cable crossings and observed the landscape and the light. The gorge, narrow and deep, was often in dark shadows. I studied people zipping across, flying over the churning waters of the Nu (the word means "angry" in Chinese). They did it alone, in pairs, and with animals. I saw chickens, pigs, a goat.

I located the zip line closest to a town and headed there on market day with my assistant, Chuan Jianhua, and our driver, Zhu Linwen (both members of the Lisu minority). A steady stream of people were already making the crossing. I rented a harness and pulley from one of them. With a camera around my neck and film in my pocket, I hooked the pulley onto the return cable and eased forward until I reached midway above the river.

The waters did look angry. Dangling over the Nu, I photographed people crossing until those waiting to return home became impatient with me. I pulled myself back to the roadside to let them pass, then



hooked onto the cable again for another try. After a morning hanging from the cable and making pictures from the riverbank, I decided to wrap it up.

As we loaded the car, we scanned the high ridges opposite us. A group of people were heading down the steep trail. Jianhua called out, "They have a cow!" I dug out a seldom used telephoto lens and looked to the ridgetop. Indeed, there was a cow (and a goat as well). The path split in two directions. I held my breath as we watched the group descend. Linwen thumbed prayer beads. Jianhua recited a prayer in the Lisu dialect. When the people with the cow chose the path toward the cable crossing, a shot of adrenaline made my toes tingle.

What's the angle? I asked myself, as I raced along the riverbank. I needed the river waters in the composition but that was tough to do. Before I could check all the possibilities, the group was at the cable and Nan Boyi (above) zipped across confidently.

His family tied a rope sling around the cow, hooked it on the pulley, and gave the animal a push toward us. Flailing its legs as it became airborne, the cow zipped down the steep angle of the cable but lost momentum where the line flattened out. It dangled there kicking, its lows of distress audible above the river's roar.

Boyi pulled himself hand over hand back to the cow. Once there the Lisu villager spun himself around, locked his ankles around the cow's harness, and began hauling himself and the cow back up to the road.

I reached the cable's end just as Boyi and the cow closed in. For a fraction of a second, my camera was in Boyi's face. The view was immediate and intimate—completed by the angry river below.

Many years later, the dams have not yet been built, but this zip line has been replaced by a bridge. ☐

Fritz Hoffmann began photographing China in 1994. He has photographed many feature stories for the magazine, including the January 2019 story on Chinese medicine.

NORWEGIAN COOL

The Lofoten Islands are among the world's most scenic and formidable

ALL ABOARD

Enveloped by Arctic currents and narrow fjords, the Lofoten archipelago lures thrill seekers—including wintertime surfers. Riding the frigid waves here requires a dose of Norwegian *indre kraft,* or inner strength.

In the past decade, technical advances in cold water attire have made it possible to spend much more time in normally numbing temperatures. "It's just us, our surfboards, and the vastness of nature," says German surfer Aline Bock (seen here with pal Lena Stoffel).

ISLAND LIFE

After surfing, stand-up paddleboarding, or hiking, adventurers can break their icy isolation by warming up to the centuries-old fishing culture that defines the islands. Among the weathered red *rorbu* cabins, racks of cod dry in the wind, providing the main ingredient for the local fish stew.

Daylight is fleeting above the Arctic Circle in winter, which gives ample opportunity to chase the green swirls of the northern lights, especially around the villages of Reine and Svolvær.

AN ECO-FOCUS

Awarded a "sustainable destination" seal of approval by the Global Sustainable Tourism Council, the Lofoten archipelago has focused on preserving its culture and reducing the negative impact of tourism.

As climate change causes glaciers to melt and sea levels to rise, the islands' waves may eventually become too treacherous to ride. Successful conservation efforts, such as ending offshore fossil fuel development, could benefit the environment as well as the people.

‘WHEN THE PERFECT WAVE COMES AND YOU CATCH IT REALLY WELL, IT’S PURE JOY AND HAPPINESS.’

—Aline Bock, surfer

destinations for winter surfing.

BY THE NUMBERS

18

POPULATION OF UNSTAD, THE ISLANDS’ MOST FAMOUS SURF SPOT

41°F

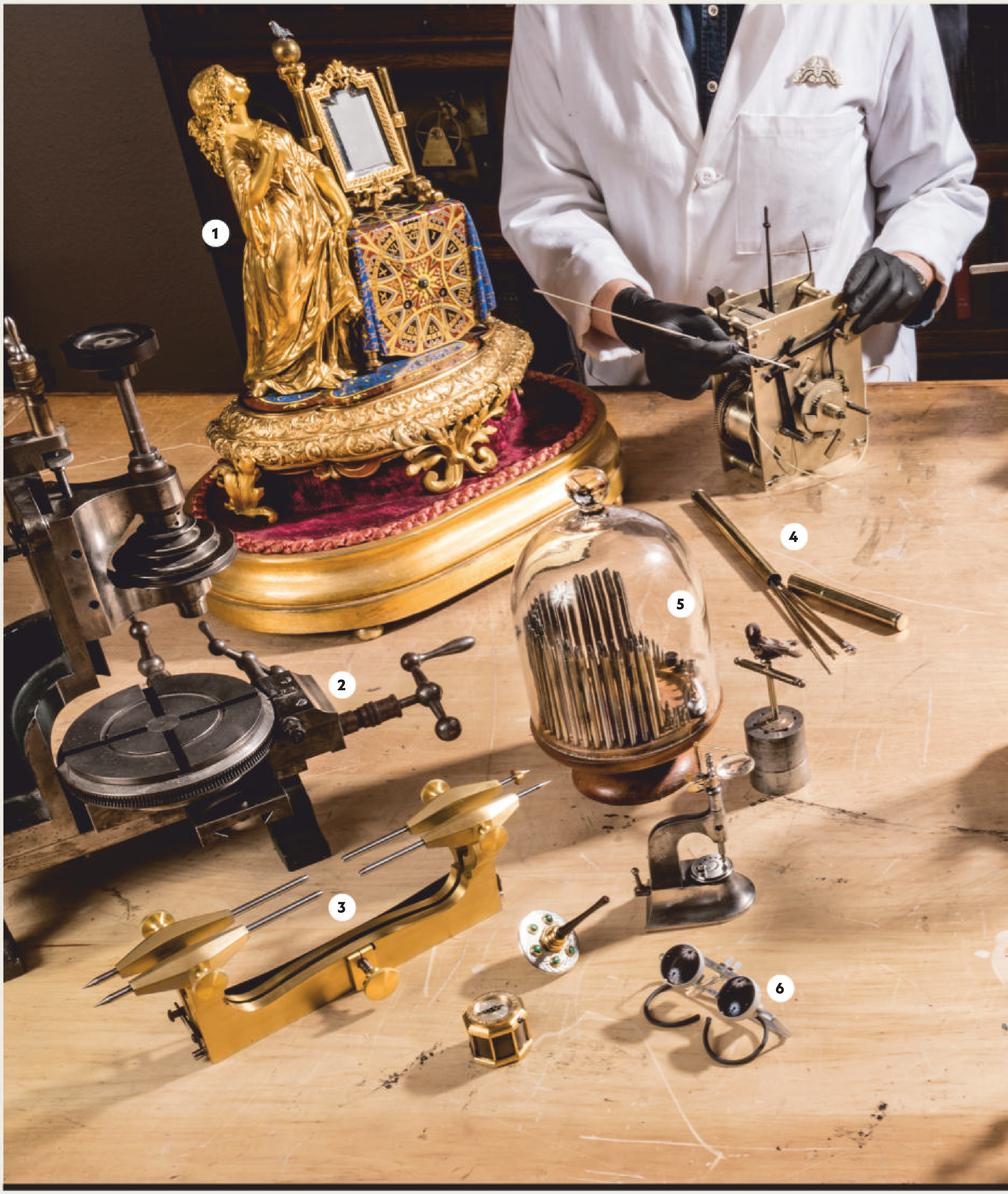
AVERAGE WATER TEMPERATURE IN FEBRUARY

120

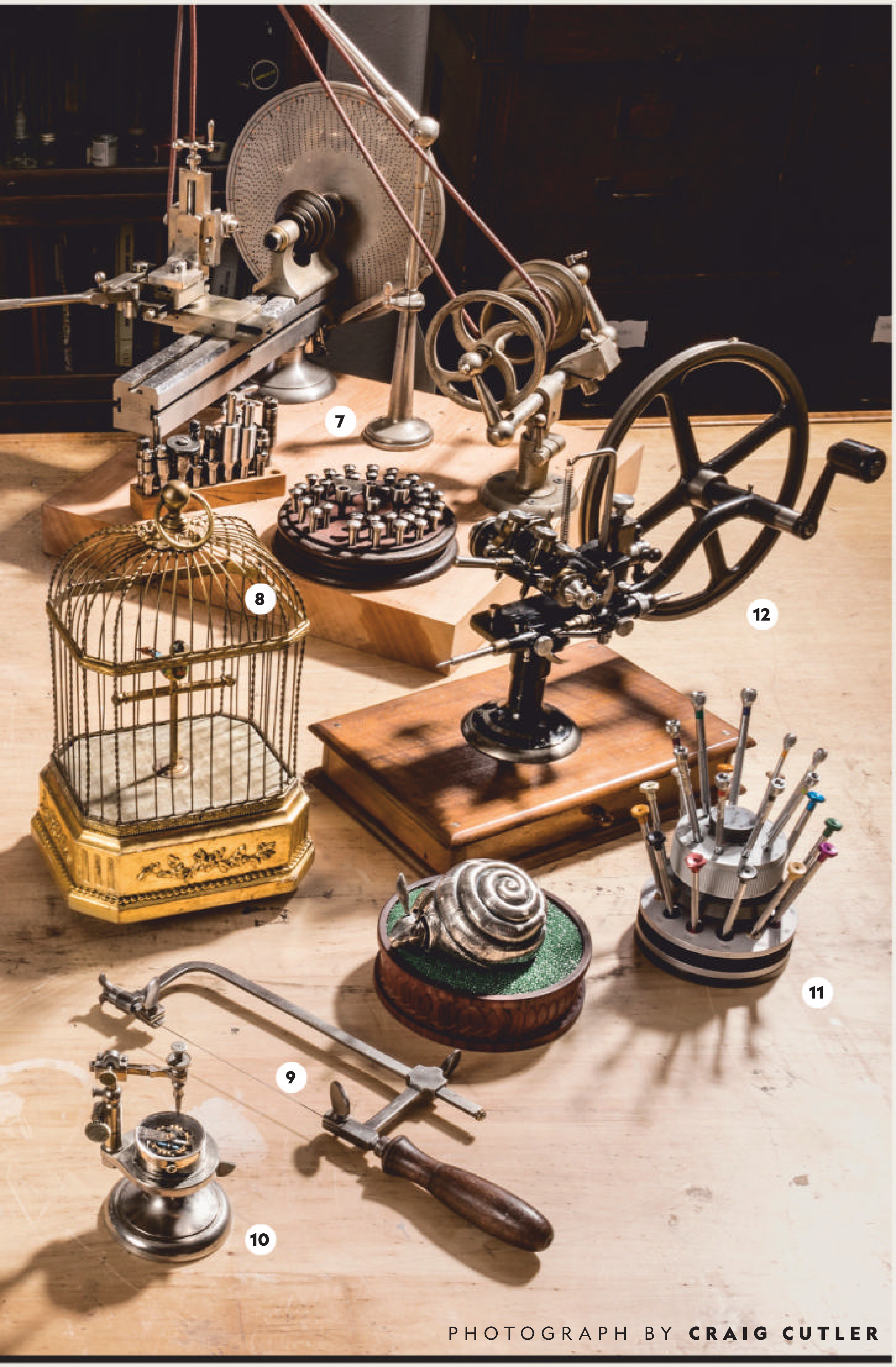
MILES ABOVE THE ARCTIC CIRCLE

BY **LOLA AKINMADE ÅKERSTRÖM** PHOTOGRAPH BY **ANDREA FRAZZETTA**

NGM MAPS



TIMELESS TIME MACHINES



PHOTOGRAPH BY **CRAIG CUTLER**

POPPING INTO A HARDWARE STORE won't do when Brittany Nicole Cox needs parts or tools. She's an antiquarian horologist, trained to conserve and restore historic clocks and the clockwork showpieces called automatons (**1** and **8**, above). "I work on objects created before mass production, before the standardization of things like screw threading," Cox explains. So when she needs to replace a part in a delicate mechanism that may have sat frozen for a century, she builds it in her Seattle workshop, often using tools that also are antiques. "There's such craft and art in them," she says. —LYNNE WARREN

2. Vertical milling and drilling machine
Likely built more than 100 years ago, this sturdy device is still precise at milling recesses in mechanism plates and other small parts, Cox says.

3. Depthing tool
By gauging how to position gears, this tool ensures that power in a gear train is transmitted efficiently and without undue wear.

4. Reaching tools
Like brass and steel extensions of her hands, these help Cox line up parts within a movement.

5. Staking set
This art's quintessential tool—stakes in many sizes plus a holder for the stake in use—has many functions, including adjusting and setting tiny parts.

6. Loupes
To clearly see her work's minute details, Cox uses a pair of magnifiers mounted in an eyeglass frame.

7. Watchmaker's lathe
Specially made to cut gears, this custom-built lathe was modeled on one associated with automotive pioneer Henry Ford, an avid watch tinkerer.

9. Jeweler's saw
Cox found this delicate handsaw at a small shop in England during her graduate studies there. "It was probably made in the late 19th century," she says, "and I use it all the time."

10. Vibrating tool
To keep accurate time, a wind-up watch requires a balance spring that oscillates at a specific rate—up to 36,000 beats an hour, depending on the mechanism. This Swiss-made device adjusts balance springs to oscillate at 18,000 beats an hour.

11. Custom screwdrivers
Color-coded for size, this double stack of modern watchmaker's screwdrivers includes blades Cox has modified to fit nonstandard antique screwheads.

12. Wheel-topping tool
Cox uses this early 20th-century cast-iron device to reshape worn gear teeth.

INNOVATOR

TOMAS DIAGNE

BY **ANNIE ROTH** PHOTOGRAPH BY **REBECCA HALE**

He wants the 'homeland of the turtle' to lead in conserving the reptile.

About 260 million years ago the earliest ancestor of turtles and tortoises, a bulbous reptile known as *Eunotosaurus africanus,* emerged from an egg in South Africa's Karoo Basin. Its evolutionary descendants spread around the globe, giving rise to the turtles and tortoises living today.

"Africa is the homeland of the turtle, yet they are totally overlooked here," says conservationist and National Geographic Explorer Tomas Diagne. In his home country of Senegal and across much of Africa, habitat loss and overharvesting have imperiled many species of turtles—but little attention has been paid to their plight, he says. Determined to change that, Diagne has devoted the past 25 years to studying, rescuing, captive breeding, and reintroducing threatened and endangered tortoises and turtles in Senegal.

As a teenager, Diagne spent a lot of time rescuing sick and injured African spurred tortoises, the third largest tortoise (some males grow to 200 pounds). Eventually, his hobby blossomed into a career in reptile conservation. In 2009 he founded the African Chelonian Institute, Africa's first conservation organization dedicated solely to the preservation of the continent's 60 turtle and tortoise species. By inspiring the next generation of African turtle researchers, Diagne hopes to make the continent a world leader in turtle conservation. □

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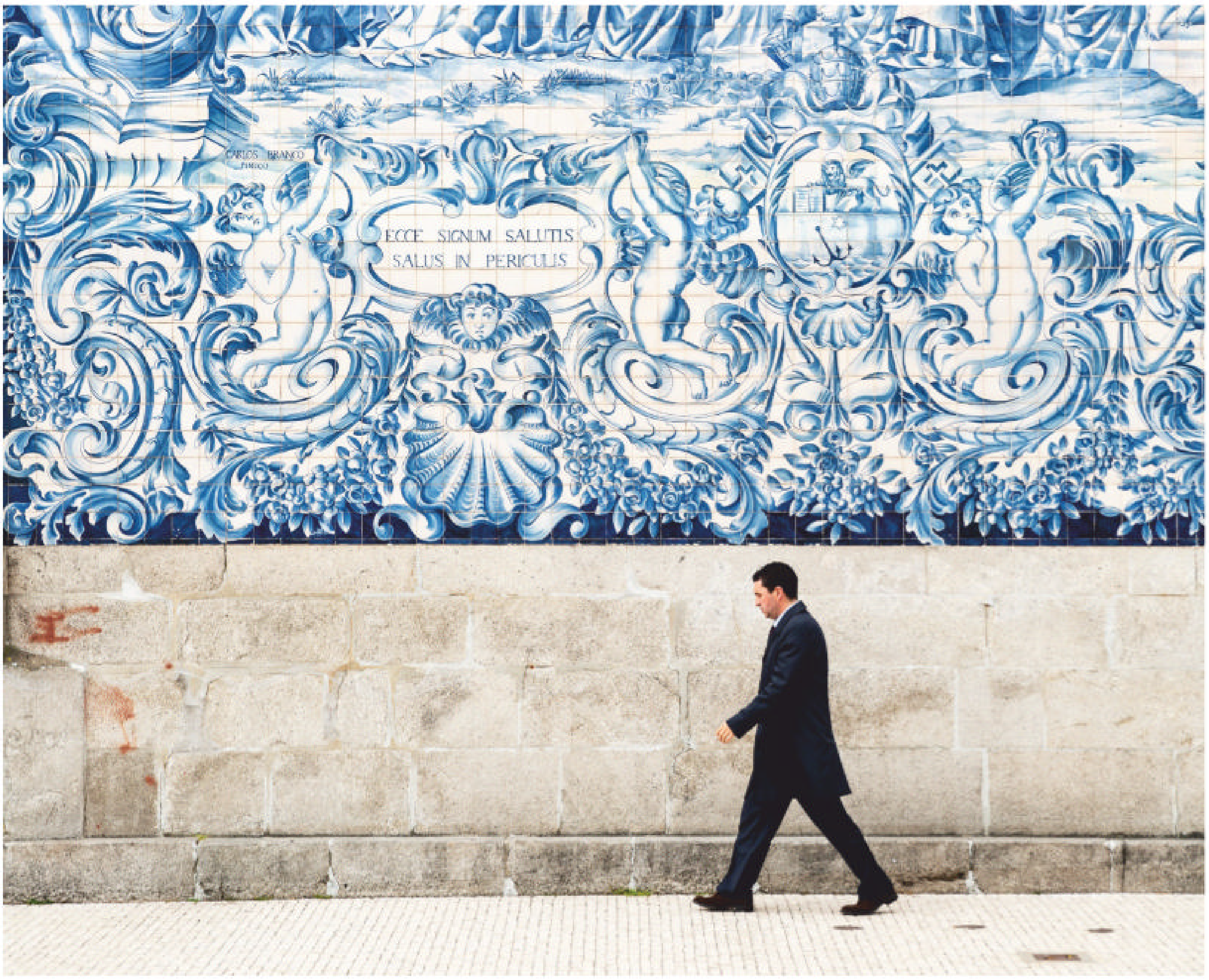

Installed in 1910, azulejos portraying the founding of the Carmelite Order decorate the 18th-century Carmo Church in Porto, Portugal.

THESE TILES TELL TALES

PAINTED AZULEJOS RECALL PORTUGAL'S LEGACY OF EXPLORATION AND ENDURE THROUGH TIME—AND THEFT.

BY **HELENA AMANTE**

IN AN OBSCURE ALLEYWAY near Lisbon's Alcântara neighborhood, the Fábrica Sant'Anna has been producing azulejos—the Portuguese word for wall tiles—roughly the same way since the workshop's founding in 1741. At long tables scattered with pots of myriad colors, artisans paint angels and flowers, graceful swirls and bold lines, onto gleaming white ceramic squares.

But if Sant'Anna's buzzing factory has become something of a pilgrimage site for visitors to the Portuguese capital, seeing azulejos in Lisbon requires no effort at all. You'd have to walk the streets with your eyes closed to miss them.

Throughout Portugal, azulejos are an inextricable part of the landscape. But like the tropical trees of Lisbon, brought to the city from faraway lands centuries ago, azulejos are particularly representative of Portuguese identity precisely because they're so tied to other latitudes.

In repeating motifs or one-of-a-kind panels, the five-by-five-inch icons lend character to buildings and monuments inside and out, but it's in the landscape of a thousand designs that their multicultural richness shines through.

Although quieter in the wake of COVID-19, without groups of visitors peeking in at the process, the

PHOTO: REBECCA STUMPF

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country's azulejo workshops continue to reproduce classics and devise new patterns, both for local and international admirers. The popularity of this 500-year-old tradition—which has endured fashions, theft, and modernization—remains undimmed.

At the helm of the Museu Nacional do Azulejo in Lisbon, Maria Antónia Pinto de Matos cringes every time she has to translate the word azulejo. "All historical and cultural nuances get lost in translation," she says.

"Tile" says nothing of the azulejo's artistry, detail, and continuous evolution in both technique and aesthetic; nor can it convey how azulejos are as much about light and reflection as patterns or colors. The many influences that have gone into the development of azulejos would never fit into a single panel—though, taken together, they create a multifaceted picture of Portugal's history at home and abroad.

The museum is housed in an early 16th-century convent constructed when explorers, such as Portuguese navigator Ferdinand Magellan, were expanding European power and influence into the Americas and the Pacific.

The museum's collection spans five centuries of history, from the geometric patterns rooted in azulejos' Islamic origins to contemporary designs familiar to anyone who rides Lisbon's metro. On the museum's upper floor, one display in particular leaves a lasting impression: a 72-foot-wide panoramic panel of Lisbon prior to the devastating earthquake of 1755.

Ironically, Lisbon's greatest misfortune marked a turning point for azulejos. Previously mostly an indoor feature, azulejos made the leap from interior to exterior as the city was rebuilt with the reassuring depiction of saints and angels to guard facades from future harm. Highly resistant to the whims of weather and relatively cheap to produce, azulejos became the dominant cladding solution in the 19th century, one that simultaneously allowed vivid embellishment.

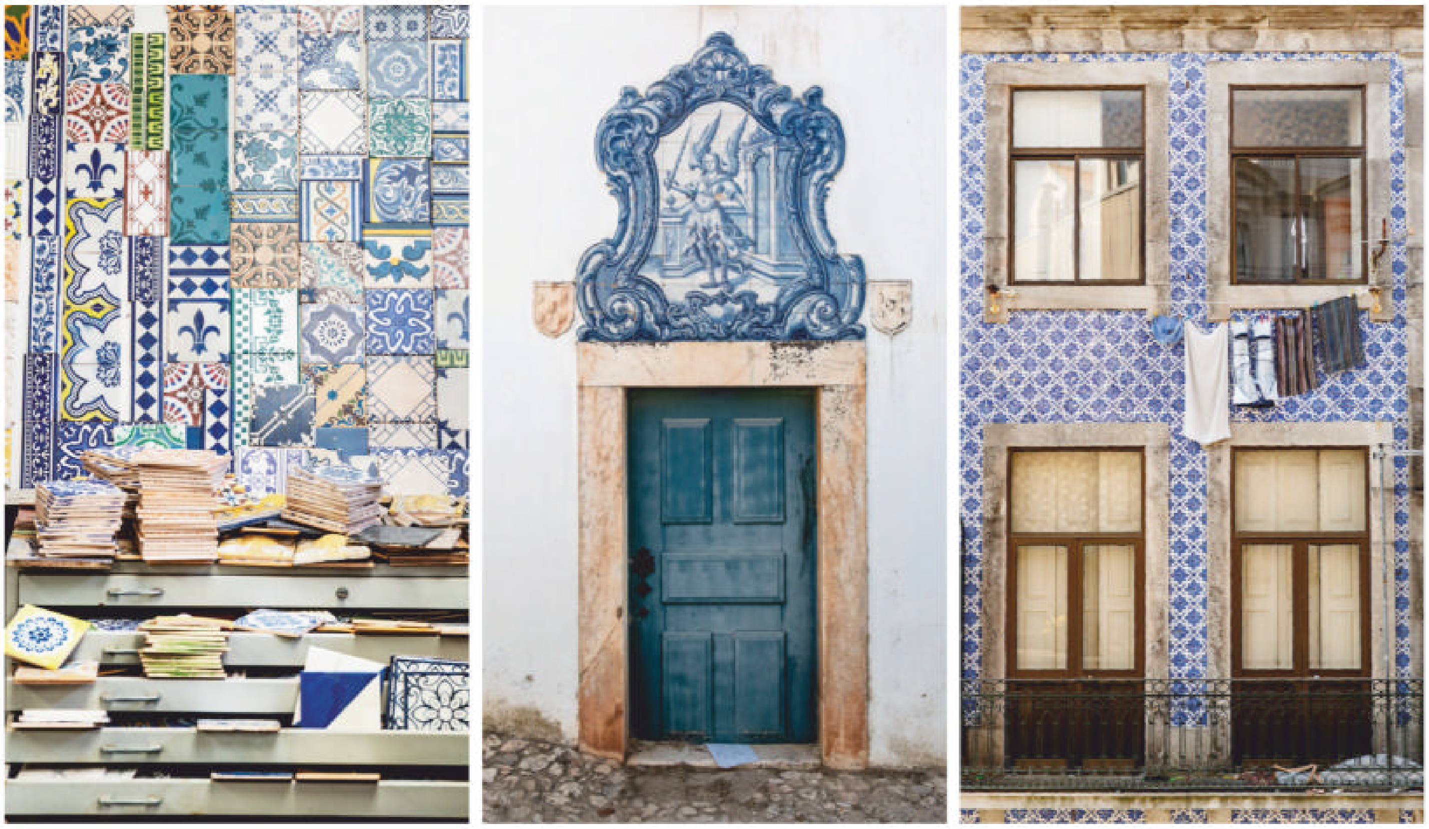
While tiles in Porto and the north display a preference for relief, the multitude of azulejo patterns throughout the country hasn't muted a strong storytelling dimension.

The tiles also leave their mark globally. "The presence of azulejos is traceable all along the old commercial routes," says Francisco Tomás, marketing manager at Fábrica Sant'Anna. "Even today, alongside new projects, we restore works we've completed for far-off locations, some from over a hundred years ago."

Azulejos have become victims of their own abiding popularity. Stolen tiles, removed from facades to make an easy profit, began showing up at flea markets. "We worked on protective laws and awareness campaigns, and attitudes have changed," says Leonor Sá, coordinator of the SOS Azulejo Project, which helps to safeguard the tiles' heritage. "Locals are more protective and tourists more concerned about provenance."

It's not surprising that azulejos have become postcards of Portugal. But, in their dovetailing of many cultural encounters, azulejos also evoke the act of traveling. From Lisbon to Salvador, Brazil, to Goa, India, azulejos' long journey has always been written over land and the seven seas. □

Based in Lisbon, **Helena Amante** is a writer and art director whose work covers culture, travel, and creativity.



Introduced by the Moors in the 13th century, azulejos weren't produced widely in Portugal until the 1500s. Each tile conveys a unique story about the artist who created the design, the factory where it was made, or the time period during which it was produced.

PHOTOS: REBECCA STUMPF (LEFT AND RIGHT), FRANCESCO LASTRUCCI (CENTER). NGM MAPS

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FEATURES

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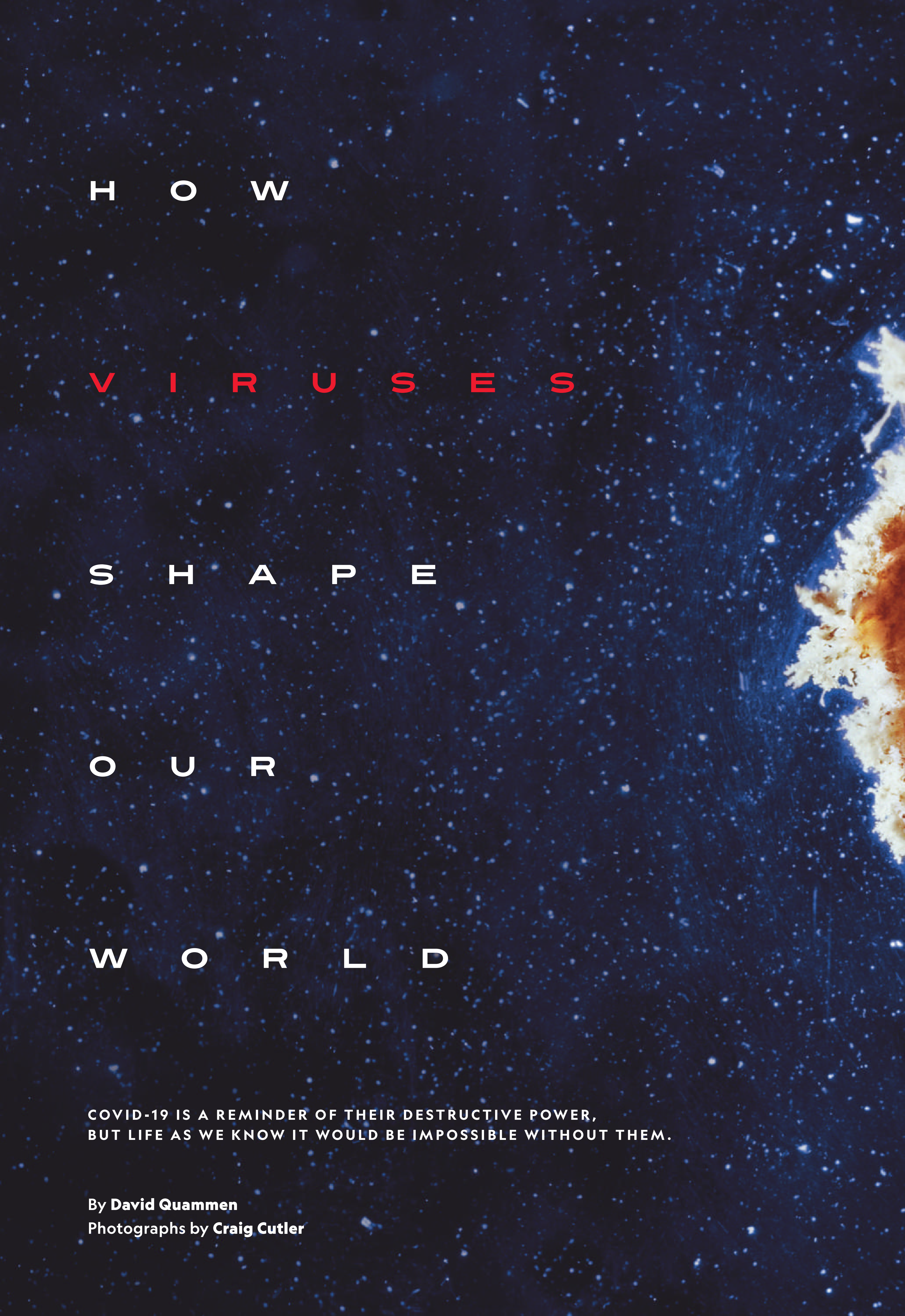
'FOR WOMEN WHO FACE FAMINE OR DANGER IN THEIR HOME COUNTRIES, MIGRATION IS A GAMBLE FOR THEIR VERY SURVIVAL.'

PHOTO OF A SOMALI MOTHER AND DAUGHTER AT A REFUGEE CAMP IN KENYA BY NICHOLE SOBECKI

HOW VIRUSES SHAPE OUR WORLD

COVID-19 IS A REMINDER OF THEIR DESTRUCTIVE POWER, BUT LIFE AS WE KNOW IT WOULD BE IMPOSSIBLE WITHOUT THEM.

By **David Quammen**
Photographs by **Craig Cutler**



Although feared as agents of disease, viruses also work wonders, shaping evolution from the very beginning. About 8 percent of our DNA comes from viruses that infected our long-ago ancestors and patched viral genes into their genomes. Some of these genes now play crucial roles in the early stages of the developing embryo and the placenta that surrounds this 13-week-old fetus.

LENNART NILSSON, TT/SCIENCE PHOTO LIBRARY (COMPOSITE OF TWO IMAGES)

As a zebra shark cruises by, a diver at Aquarium of the Pacific in Long Beach, California, displays an image of a bacteriophage, a type of virus that infects bacteria. Harmless to plants and animals, bacteriophages are critical for healthy marine ecosystems. The Earth's oceans teem with these and other viruses. The aquarium's Tropical Reef Habitat and Soft Coral Garden hold 367,166 gallons of water, with an estimated 5.32 quadrillion viruses. If lined up side by side, those viruses would circle the Earth almost eight times.

DOMINIK HREBÍK AND PAVEL PLEVKA, LABORATORY OF STRUCTURAL VIROLOGY, CEITEC, MASARYK UNIVERSITY, CZECH REPUBLIC (BACTERIOPHAGE)

A Neanderthal skull, one of the most complete yet found, rests near human skeletons in the Musée de l'Homme in Paris. When modern humans left Africa, they interbred with Neanderthals and instantly acquired genes that had evolved over hundreds of thousands of years. Scientists have found 152 genes inherited from Neanderthals that help create an immune response. They have concluded that these genes enabled our ancestors to fight the new viruses they encountered in Europe.

RÉMI BÉNALI

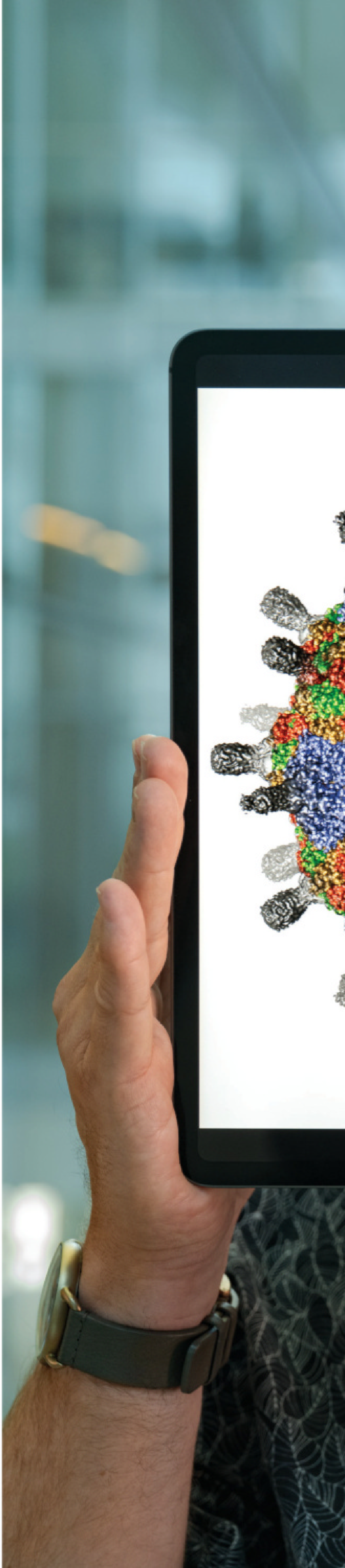
LET'S IMAGINE PLANET EARTH WITHOUT VIRUSES.

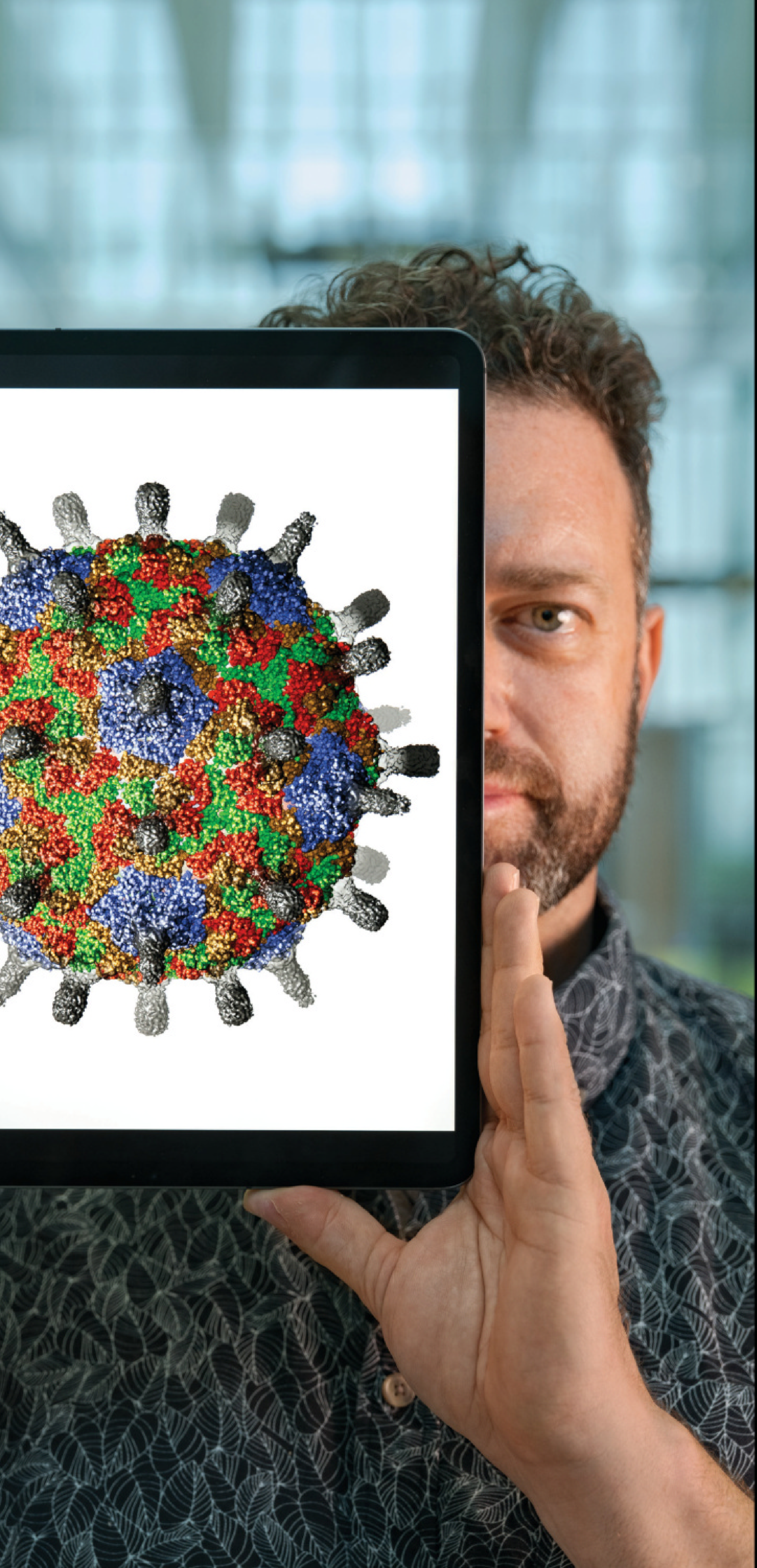
We wave a wand, and they all disappear. The rabies virus is suddenly gone. The polio virus is gone. The gruesomely lethal Ebola virus is gone. The measles virus, the mumps virus, and the various influenzas are gone. Vast reductions of human misery and death. HIV is gone, and so the AIDS catastrophe never happened. Nipah and Hendra and Machupo and Sin Nombre are gone—never mind their records of ugly mayhem. Dengue, gone. All the rotaviruses, gone, a great mercy to children in developing countries who die by the hundreds of thousands each year. Zika virus, gone. Yellow fever virus, gone. Herpes B, carried by some monkeys, often fatal when passed to humans, gone. Nobody suffers anymore from chicken pox, hepatitis, shingles, or even the common cold. Variola, the agent of smallpox? That virus was eradicated in the wild by 1977, but now it vanishes from the high-security freezers where the last spooky samples are stored. The SARS virus of 2003, the alarm that we now know signaled the modern pandemic era, gone. And of course the nefarious SARS-CoV-2 virus, cause of COVID-19 and so bewilderingly variable in its effects, so tricky, so dangerous, so very transmissible, is gone. Do you feel better?

Don't.

This scenario is more equivocal than you think. The fact is, we live in a world of viruses—viruses that are unfathomably diverse, immeasurably abundant. The oceans alone may contain more viral particles than stars in the observable universe. Mammals may carry at least 320,000 different species of viruses. When you add the viruses infecting nonmammalian animals, plants, terrestrial bacteria, and every other possible host, the total comes to … lots. And beyond the big numbers are big consequences: Many of those viruses bring adaptive benefits, not harms, to life on Earth, including human life.

We couldn't continue without them. We wouldn't have arisen from the primordial muck without them. There are two lengths of DNA that originated from viruses and now reside in the genomes of humans and other primates, for instance,





Jason Shepherd, a neuroscientist at the University of Utah, holds an image of a three-dimensional reconstruction of a virus-like protein capsule that plays a critical role in cognition and memory. The *ARC* gene, which carries the code to create this spherical marvel, was acquired by terrestrial vertebrates from a viral-like ancestor about 400 million years ago. The capsule, which resembles the capsids that surround viral genomes, ferries genetic information between neurons in the human brain (above) as well as in the brains of many other animals.

SIMON ERLENDSSON, MRC LABORATORY OF MOLECULAR BIOLOGY (CAPSULE); ROBERT CLARK (BRAIN)

without which—an astonishing fact—pregnancy would be impossible. There's viral DNA, nestled among the genes of terrestrial animals, that helps package and store memories—more astonishment—in tiny protein bubbles. Still other genes co-opted from viruses contribute to the growth of embryos, regulate immune systems, resist cancer—important effects only now beginning to be understood. Viruses, it turns out, have played crucial roles in triggering major evolutionary transitions. Eliminate all viruses, as in our thought experiment, and the immense biological diversity gracing our planet would collapse like a beautiful wooden house with every nail abruptly removed.

A virus is a parasite, yes, but sometimes that parasitism is more like symbiosis, mutual dependence that profits both visitor and host. Like fire, viruses are a phenomenon that's neither in all cases good nor in all cases bad; they can deliver advantage or destruction. Everything depends: depends on the virus, on the situation, on your point of reference. They are the dark angels of evolution, terrific and terrible. That's what makes them so interesting.

TO APPRECIATE the multifariousness of viruses, you need to start with the basics of what they are and what they are not. It's easier to say what they are not. They are not living cells. A cell, of the sort assembled in great number to make up your body or mine or the body of an octopus or a primrose, contains elaborate machinery for building proteins, packaging energy, and performing other specialized functions—depending on whether that cell happens to be a muscle cell or a xylem cell or a neuron. A bacterium is also a cell, with similar attributes, though much simpler. A virus is none of this.

Saying just what a virus *is* has been complicated enough that definitions have changed over the past 120-some years. Martinus Beijerinck, a Dutch botanist who studied tobacco mosaic virus, speculated in 1898 that it was an infectious liquid. For a time a virus was defined mainly by its size—a thing much smaller than a bacterium but that, like bacteria, could cause disease. Still later, a virus was thought to be a submicroscopic agent, bearing only a very small genome, that replicated inside living cells—but that was just a first step toward a better understanding.

"I shall defend a paradoxical viewpoint," wrote the French microbiologist André Lwoff in "The Concept of Virus," an influential essay published in 1957, "namely that *viruses are viruses.*" Not a very helpful definition but fair warning—another way of saying "unique unto themselves." He was just clearing his throat before beginning a complex disquisition.

Lwoff knew that viruses are easier to describe than to define. Each viral particle consists of a stretch of genetic instructions (written either in DNA or that other information-bearing molecule, RNA) packaged inside a protein capsule (known as a capsid). The capsid, in some cases, is surrounded by a membranous envelope (like the caramel on a caramel apple), which protects it and helps it catch hold of a cell. A virus can copy itself only by entering a cell and commandeering the 3D-printing machinery that turns genetic information into proteins.

If the host cell is unlucky, many new viral particles are manufactured, they come busting out, and the cell is left as wreckage. That sort of damage—such as what SARS-CoV-2 causes in the epithelial cells of the human airway—is partly how a virus becomes a pathogen.

But if the host cell is lucky, maybe the virus simply settles into this cozy outpost—either going dormant or back-engineering its little genome into the host's genome—and bides its time. This second possibility carries many implications for the mixing of genomes, for evolution, even for our sense of identity as humans, a topic to which I'll return. One hint, for now: In a popular 1983 book the British biologist Peter Medawar and his wife, Jean, an editor, asserted, "No virus is known to do good: It has been well said that a virus is 'a piece of bad news wrapped up in protein.'" They had it wrong. So did a lot of scientists at the time, and it remains a view still embraced, understandably, by anyone whose knowledge of viruses is limited to such bad news as the flu and COVID-19. But today some viruses are known to do good. What's wrapped up in the protein is a genetic dispatch, and that might turn out to be good news or bad, depending.

WHERE DID THE FIRST VIRUSES come from? This requires us to squint back almost four billion years, to the time when life on Earth was just emerging from an inchoate cookery of long molecules, simpler organic compounds, and energy.

Let's say some of the long molecules (probably RNA) started to replicate. Darwinian natural selection would have begun there, as those molecules—the first genomes—reproduced, mutated, and evolved. Groping for competitive edge, some may have found or created protection within membranes and walls, leading to the first cells. These cells gave rise to offspring by fission, splitting in two. They split in a broader sense too, diverging to become Bacteria and Archaea, two of the three domains of cellular life. The third, Eukarya, arose sometime later. It includes us and all other creatures (animals, plants, fungi, certain microbes) composed of cells with complex internal anatomy. Those are the three great limbs on the tree of life, as presently drawn.

But where do viruses fit? Are they a fourth major limb? Or are they a sort of mistletoe, a parasite wafted in from elsewhere? Most versions of the tree omit viruses entirely.

One school of thought asserts that viruses shouldn't be included on the tree of life because they aren't alive. That's a lingering argument, hinging on how you define "alive." More intriguing is to grant viruses inclusion within the big tent called Life, and then wonder about how they got in.

There are three leading hypotheses to explain the evolutionary origins of viruses, known to scientists as viruses-first, escape, and reduction. Viruses-first is the notion that viruses came into existence before cells, somehow assembling themselves directly from that primeval cookery. The escape hypothesis posits that genes or stretches of genomes leaked out of cells, became encased within protein capsids, and went rogue, finding a new niche as parasites. The reduction hypothesis suggests that viruses originated when some cells downsized under competitive pressure (it being easier to replicate if you're small and simple), shedding genes until they were reduced to such minimalism that only by parasitizing cells could they survive.

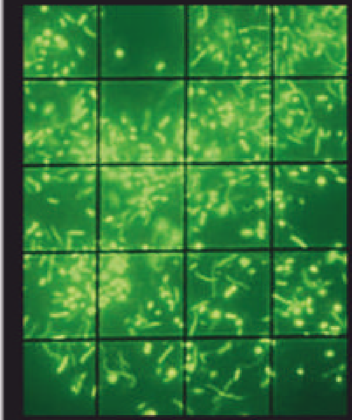
There is also a fourth variant, known as the chimeric hypothesis, which takes inspiration from another category of genetic elements: transposons (sometimes called jumping genes). The geneticist Barbara McClintock deduced their existence in 1948, a discovery that earned her a Nobel Prize. These opportunistic elements achieve their Darwinian success simply by bouncing from one part of a genome to another, in rare cases from one cell to another, even one species to another, using cellular resources to get themselves copied, over and over. Self-copying protects them from accidental extinction. They accumulate outlandishly. They constitute, for instance, roughly half of the human genome. The earliest viruses, according to this idea, may have arisen from such elements by borrowing proteins from cells to wrap their nakedness inside protective capsids, a more complex strategy.

Each of these hypotheses has merits. But in 2003 new evidence tipped expert opinion toward reduction: the giant virus.

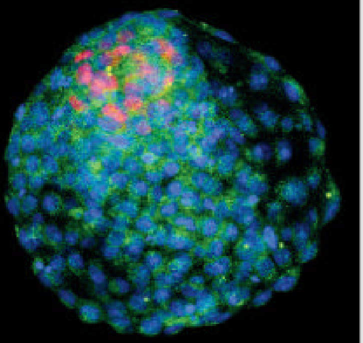
IT WAS FOUND within amoebas, which are single-celled eukaryotes. These amoebas had been collected in water taken from a cooling tower in Bradford, England. Inside some of them was this mysterious blob. It was big enough to be seen through a light

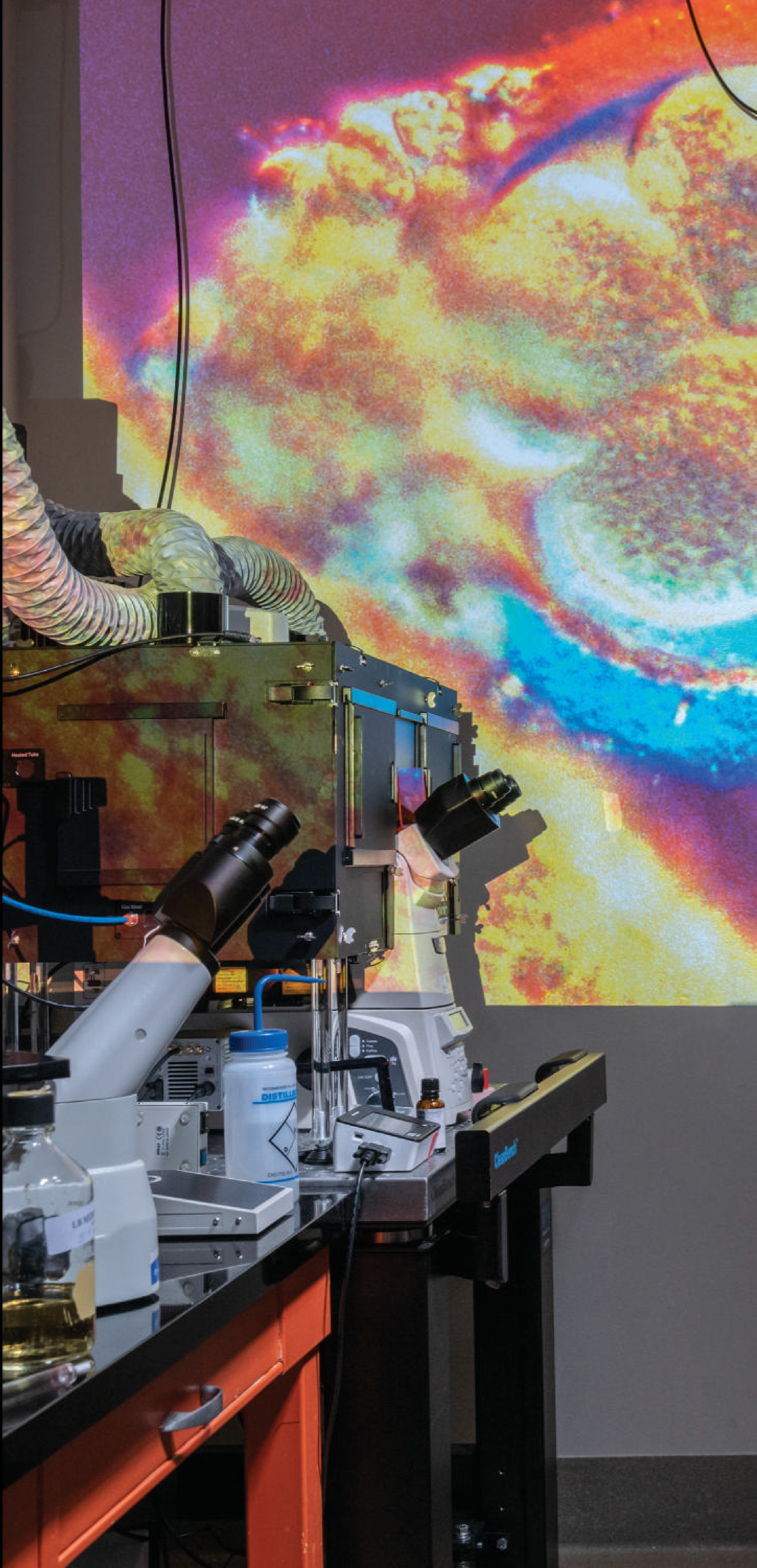
How to count viruses

To count viruses in the Aquarium of the Pacific's Tropical Reef Habitat and Soft Coral Garden, we enlisted Alexandra Rae Santora, a doctoral student working with Jed Fuhrman, a professor at the University of Southern California. She ran a sample through a 0.02-micron filter, which catches bacteria and viruses. She used a DNA-binding stain to make them visible under an epifluorescence microscope. The larger organisms are bacteria; the dots are viruses. With a counting grid, she determined the number of viruses in the field of view. Knowing the filter size and the volume of water allowed her to calculate the population per gallon.



ALEXANDRA RAE SANTORA





An image of a human embryo with just eight cells looms behind Joanna Wysocka, a professor of developmental biology at Stanford University. Wysocka and her colleagues discovered that a human endogenous retrovirus—a genetic sequence acquired from an ancient viral infection—turns on during this developmental stage and produces proteins. Wysocka believes the gene, known as *HERV-K,* could protect the embryo from viral infection and help control fetal development. By the time a human embryo has grown into a many-celled blastocyst (above), *HERV-K,* shown here stained green, is present throughout, but is concentrated in cells that will become a baby.

LENNART NILSSON, TT/SCIENCE PHOTO LIBRARY (EMBRYO); MARK WOSSIDLO, STANFORD UNIVERSITY/ MEDICAL UNIVERSITY OF VIENNA (BLASTOCYST)

Stanford MEDICINE
NO FOOD OR DRINKS

As far back as 150 million years ago, viruses infected mammals and left genes that led to a dramatic evolutionary advance: the placenta, which allows nutrients and oxygen to reach the fetus and waste and carbon dioxide to pass out. Humans and other mammals with placentas can move around with their unborn young, making them less vulnerable to predators. In humans, two genes originating from viruses—syncytin-1 and syncytin-2—help form the placental membrane that attaches to the uterus. This membrane also may aid in preventing the mother's immune system from attacking the fetus as a foreign object.

LENNART NILSSON, TT/SCIENCE PHOTO LIBRARY (FETUS AT 16 WEEKS). MODEL: MELODY CARBALLO, SHOWN AT 35 WEEKS

EDITOR'S NOTE

This photo of a fetus, the one on pages 40-41, and the photo of the embryo on pages 50-51 were taken by Swedish photographer Lennart Nilsson (1922-2017). His groundbreaking work documenting life before birth was first showcased in Life *magazine in 1965 and remains unsurpassed.*

microscope (viruses supposedly were too small for that, visible only by electron microscope), and it looked like a bacterium. Scientists tried to detect bacterial genes within it but found none.

Finally a team of researchers in Marseille, France, invited the thing to infect other amoebas, sequenced its genome, recognized what it was, and named it *Mimivirus,* because it mimicked bacteria, at least with regard to size. In diameter it was huge, bigger than the smallest bacteria. Its genome was also huge for a virus, almost 1.2 million letters long, compared to, say, 13,000 for an influenza virus, or even 194,000 for smallpox. (DNA, like RNA, is a long molecule built with four different molecular bases, which scientists abbreviate by their first letters.) It was an "impossible" virus: viral in nature but too big in scale, like a newly discovered Amazon butterfly with a four-foot wingspan.

Jean-Michel Claverie was a senior member of that Marseille team. The discovery of *Mimivirus,* Claverie told me, "caused a lot of trouble." Why? Because sequencing the genome revealed four very unexpected genes—genes for coding enzymes presumed to be uniquely cellular and never before seen in a virus. Those enzymes, Claverie explained, are among the components that translate the genetic code to assemble amino acids into proteins.

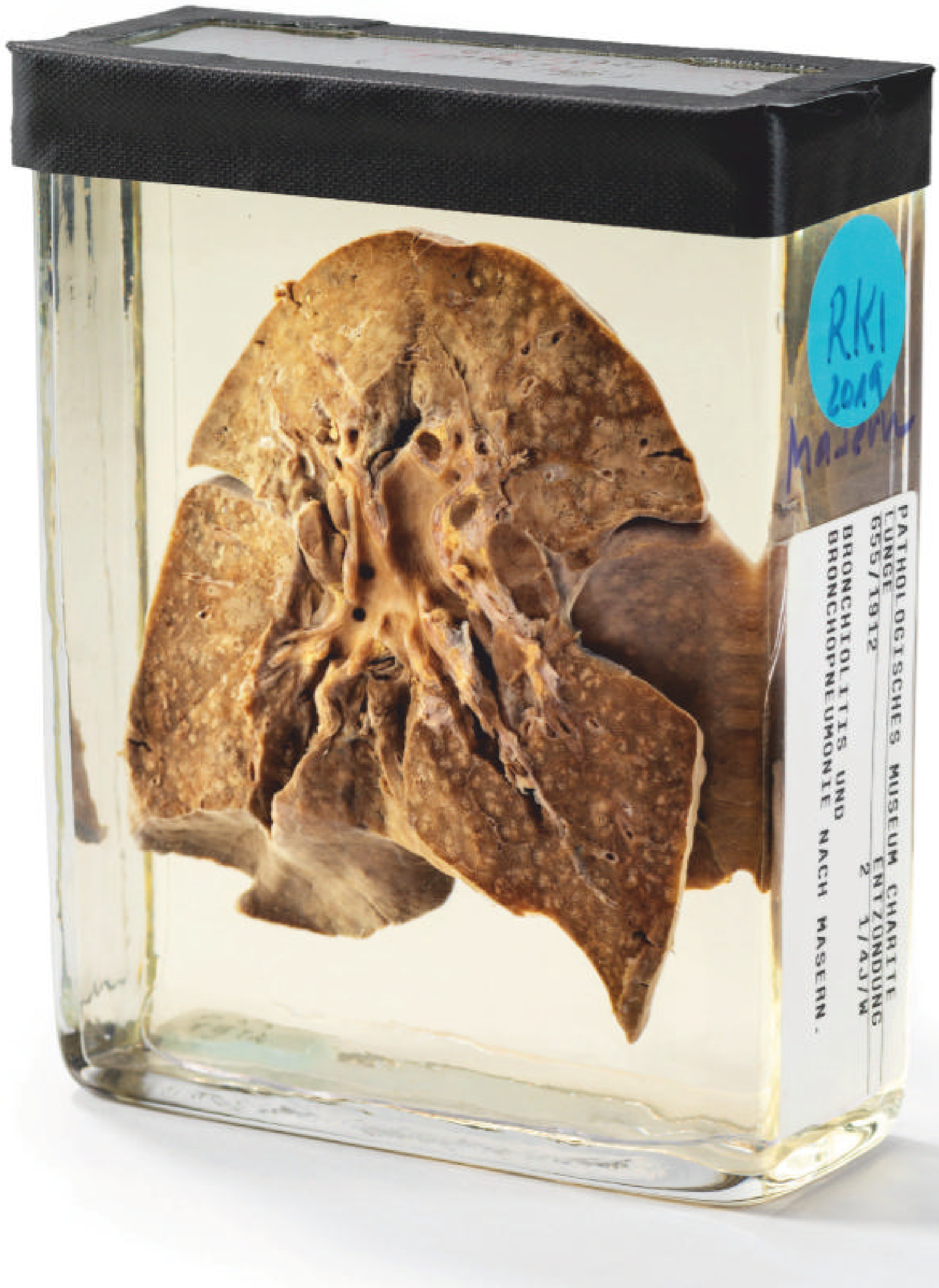
"So the question was," Claverie said, "what the hell has a virus the need" for those fancy enzymes, normally active in cells, "when he has the cell at his disposal, OK?"

What need indeed? The logical inference is that *Mimivirus* has them as holdovers because its lineage originated by genomic reduction from a cell.

Mimivirus was no fluke. Similar giant viruses were soon detected in the Sargasso Sea, and the early name became a genus, *Mimivirus,* containing several giants. Then the Marseille team discovered two more behemoths—again, both parasites of amoebas—one taken from shallow marine sediments off the coast of Chile, the other from a pond in Australia. Up to twice as big as a *Mimivirus,* even more anomalous, these were assigned to a separate genus, which Claverie and his colleagues named *Pandoravirus,* evoking Pandora's box, as they explained in 2013, because of "the surprises expected from their further study."

Claverie's senior co-author on that paper was Chantal Abergel, a virologist and structural biologist (and also his wife). Of the *Pandoraviruses,* Abergel told me, with a weary laugh: "They were highly challenging. They are my babies." She explained how difficult it had been to tell what they were, these creatures—so different from cells, so different from classical viruses, carrying many genes that resembled nothing ever before seen. "All of that makes them fascinating but also mysterious." For a while she called them NLF: *new life-form.* But from observing that they didn't replicate by fission, she and her colleagues realized they were viruses—the largest and most perplexing ones found so far.

These discoveries suggested to the Marseille group a bold variant of the reduction hypothesis. Maybe viruses did originate by reducing from ancient cells, but cells of a sort no longer present on Earth. This kind of "ancestral protocell" might



The preserved lungs of a two-year-old girl who died in 1912 at the Charité, a hospital in Berlin, offer evidence that the measles virus spilled over to humans from cattle in the fourth century B.C., more than a thousand years earlier than initially thought. Sébastien Calvignac-Spencer, an evolutionary biologist at the Robert Koch Institute, came across the specimen at Berlin's Museum of Medical History. He sequenced the measles genome, the oldest known, and used it and other measles genomes to calculate when it diverged from the cattle virus.

MARKUS BACHMANN

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ave been different from—and in competition with—the uni-ersal common ancestor of all cells known today. Maybe these rotocells lost that competition and were excluded from all he niches available for free-living things. They may have sur-ived as parasites on other cells, downsized their genomes, nd become what we call viruses. From that vanished cellular ealm, maybe only viruses remain, like the giant stone heads n Easter Island.

DISCOVERY OF THE GIANT VIRUSES inspired other scientists, notably Patrick Forterre at the Pasteur Institute in Paris, to formulate novel ideas about what viruses are and what constructive roles they ave played, and continue to play, in the evolution and functions f cellular life.

Previous definitions of “virus” were inadequate, Forterre roposed, because scientists were confusing viral particles—the apsid-enclosed bits of genome, properly known as virions—with he totality of a virus. That, he argued, was as wrong as confusing seed with a plant, or a spore with a mushroom. The virion is ust the dispersal mechanism, he argued. The real wholeness f the virus also includes its presence within a cell, once it has eized the cell’s machinery to replicate more virions, more seeds f itself. To see the two phases together is to see that the cell has ffectively become part of the virus’s life history.

Forterre bolstered that notion by inventing a new name for he combined entity: the virocell. This idea also cut through the ive-or-not-alive conundrum. A virus is alive when it’s a virocell, ccording to Forterre, never mind that its virions are inanimate.

“The idea behind the virocell concept,” he told me by Skype om Paris, “was mainly to focus on this intracellular stage.” hat’s the delicate stage when the infected cell, like a zombie, obeying the viral mandate, reading the viral genome and rep-cating it, but not always without skips, staggers, and mistakes. uring that process, Forterre said, “new genes can originate in viral genome. And this is a major point for me.” Viruses bring nnovation, but cells respond with their own defensive innova-ons, such as the cell wall or the nucleus, and so it’s an arms ace toward greater complexity. Many scientists have assumed hat viruses achieve their major evolutionary changes by the virus pickpocket” paradigm, snatching DNA from this infected rganism and that one, and then putting the stolen pieces to use ithin the viral genome. Forterre argues that the pilfering might ore often go the other way, cells taking genes from viruses.

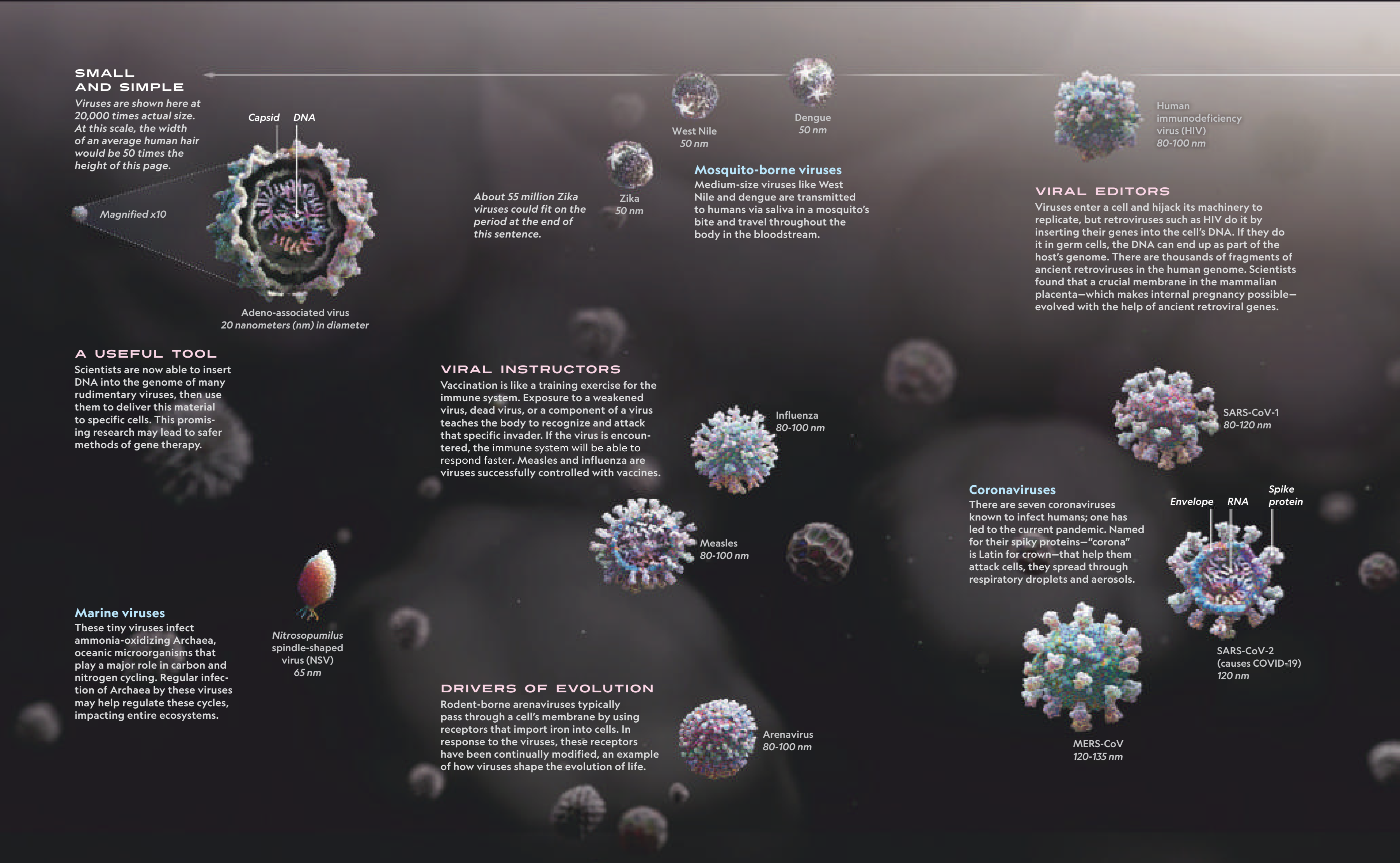
An even more sweeping view, held by Forterre and Claverie and ome other scientists in the field, including Gustavo Caetano-nollés at the University of Illinois at Urbana-Champaign, is that iruses are the preeminent font of genetic diversity. According this thinking, viruses have enriched the evolutionary options f cellular creatures over the past several billion years by depos-ing new genetic material in their genomes. This bizarre pro-ess is one version of a phenomenon known as horizontal gene ansfer—genes flowing sideways, across boundaries between

Scientists are still trying to track down where the coronavirus known as SARS-CoV-2 originated. The greater horseshoe bat and the Chinese pangolin (opposite page) have been considered as possible hosts. Viruses found in the two species are related to the pandemic virus. Maciej Boni, an associate professor of biology at Penn State University, and an international team traced the virus back about a hundred years, when coronaviruses in pangolins diverged from those in bats. SARS-CoV-2 may have evolved from the most closely related known bat viruses between 40 and 70 years ago. “Very little is known about the diversity of these viruses,” Boni said, adding that tens of thousands of avian flu virus genomes have been identified, but fewer than a hundred are known for coronaviruses. “There could in principle be viruses circulating in bats that are closer to SARS-CoV-2 or very similar to SARS-CoV-2, but we haven’t done enough studies in bats; we haven’t collected enough viruses in bats, and we just don’t know.” This bat *(Rhinolophus ferrumequinum)* was collected in the Tashkent Region of Uzbekistan in 1921; the pangolin *(Manis pentadactyla)* came from Guizhou Province in China in 1945.

PHOTOGRAPHED AT NATURAL HISTORY MUSEUM OF LOS ANGELES COUNTY (BAT AND PANGOLIN)

OUR VIRAL WORLD

Cells are considered the foundation of life, but viruses—with all their genetic diversity—may share in that role. Our planet's earliest viruses and cells likely evolved in an intertwined and often symbiotic relationship of predator and prey. Evidence even suggests that viruses may have started out as cells but lost their autonomy as they evolved to thrive as parasites on other cells. This dependent relationship began a long history of coevolution. Viruses living in cells cause their hosts to adapt, and those changes then cause viruses to adapt in a never ending cycle of one-upmanship.



SMALL AND SIMPLE

Viruses are shown here at 20,000 times actual size. At this scale, the width of an average human hair would be 50 times the height of this page.

About 55 million Zika viruses could fit on the period at the end of this sentence.

Mosquito-borne viruses

Medium-size viruses like West Nile and dengue are transmitted to humans via saliva in a mosquito's bite and travel throughout the body in the bloodstream.

VIRAL EDITORS

Viruses enter a cell and hijack its machinery to replicate, but retroviruses such as HIV do it by inserting their genes into the cell's DNA. If they do it in germ cells, the DNA can end up as part of the host's genome. There are thousands of fragments of ancient retroviruses in the human genome. Scientists found that a crucial membrane in the mammalian placenta—which makes internal pregnancy possible—evolved with the help of ancient retroviral genes.

A USEFUL TOOL

Scientists are now able to insert DNA into the genome of many rudimentary viruses, then use them to deliver this material to specific cells. This promising research may lead to safer methods of gene therapy.

VIRAL INSTRUCTORS

Vaccination is like a training exercise for the immune system. Exposure to a weakened virus, dead virus, or a component of a virus teaches the body to recognize and attack that specific invader. If the virus is encountered, the immune system will be able to respond faster. Measles and influenza are viruses successfully controlled with vaccines.

Coronaviruses

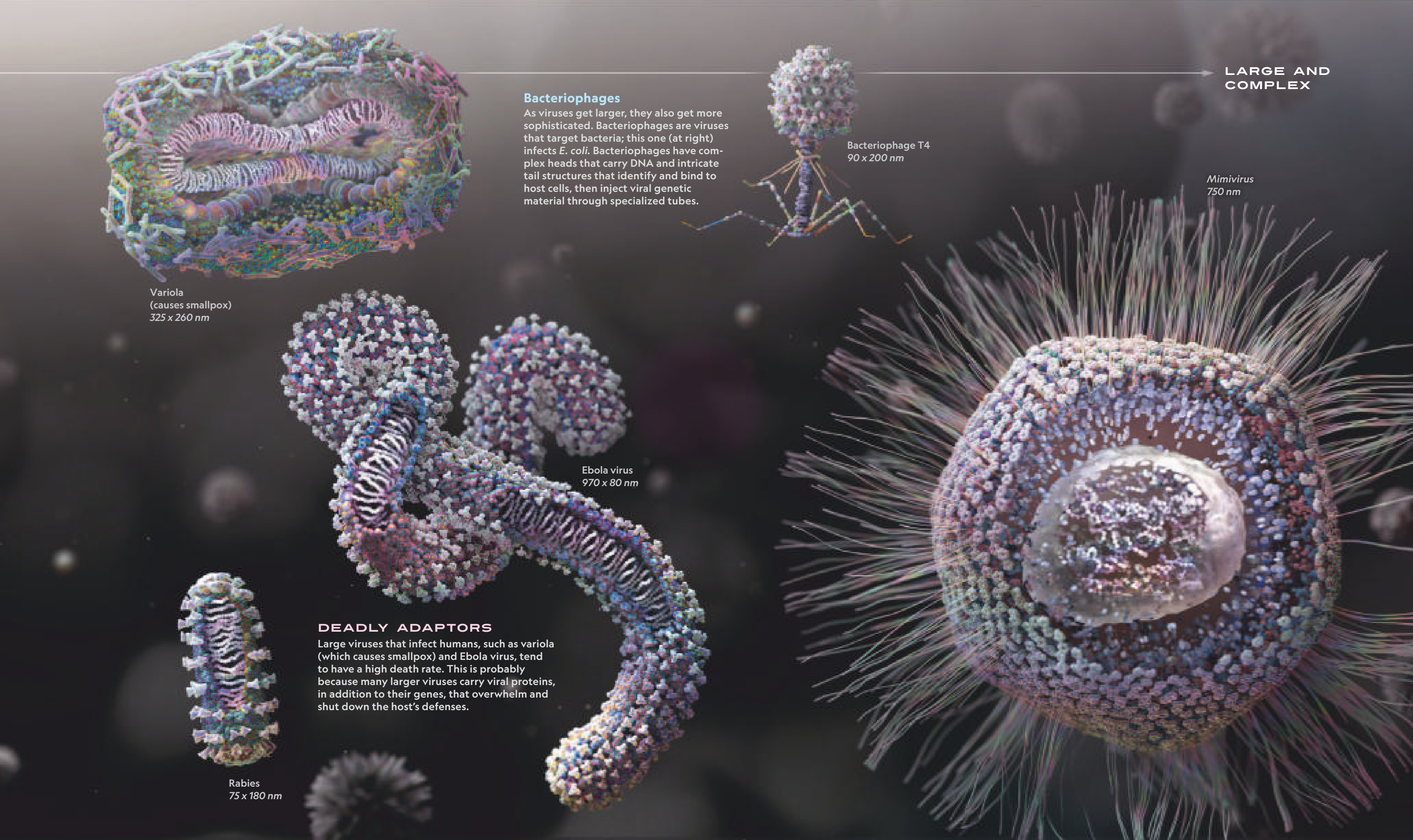
There are seven coronaviruses known to infect humans; one has led to the current pandemic. Named for their spiky proteins—"corona" is Latin for crown—that help them attack cells, they spread through respiratory droplets and aerosols.

Marine viruses

These tiny viruses infect ammonia-oxidizing Archaea, oceanic microorganisms that play a major role in carbon and nitrogen cycling. Regular infection of Archaea by these viruses may help regulate these cycles, impacting entire ecosystems.

DRIVERS OF EVOLUTION

Rodent-borne arenaviruses typically pass through a cell's membrane by using receptors that import iron into cells. In response to the viruses, these receptors have been continually modified, an example of how viruses shape the evolution of life.



Bacteriophages

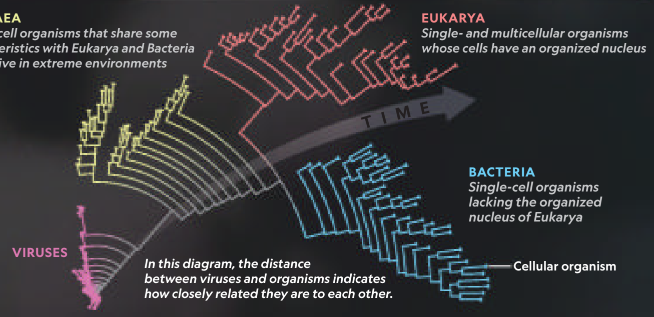
As viruses get larger, they also get more sophisticated. Bacteriophages are viruses that target bacteria; this one (at right) infects *E. coli*. Bacteriophages have complex heads that carry DNA and intricate tail structures that identify and bind to host cells, then inject viral genetic material through specialized tubes.

DEADLY ADAPTORS

Large viruses that infect humans, such as variola (which causes smallpox) and Ebola virus, tend to have a high death rate. This is probably because many larger viruses carry viral proteins, in addition to their genes, that overwhelm and shut down the host's defenses.

A MORE INCLUSIVE TREE OF LIFE?

Billions of years ago life on Earth diverged into three branches: Archaea, Bacteria, and Eukarya. But recent research suggests viruses should be considered a fourth branch. This diagram, based on comparing the shapes of proteins in viruses and cellular organisms, shows that viruses share many primitive characteristics with early cellular ancestors—and likely evolved alongside them.



ARCHAEA
Single-cell organisms that share some characteristics with Eukarya and Bacteria and thrive in extreme environments

EUKARYA
Single- and multicellular organisms whose cells have an organized nucleus

BACTERIA
Single-cell organisms lacking the organized nucleus of Eukarya

In this diagram, the distance between viruses and organisms indicates how closely related they are to each other.

BIG CLUES TO EARLY ORIGINS

The reduction hypothesis supposes that viruses downsized in favor of using their host's machinery to reproduce. New support for the idea arrived in the form of the giant viruses of the Mimiviridae family. They set up "virus factories" in host cells that may resemble some of the earliest virus-cell interactions.

JASON TREAT AND EVE CONANT, NGM STAFF; MESA SCHUMACHER
ART: MARKOS KAY. SOURCES: GUSTAVO CAETANO-ANOLLÉS, UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN; MYA BREITBART, UNIVERSITY OF SOUTH FLORIDA; EDWARD CHUONG, UNIVERSITY OF COLORADO BOULDER

different lineages. (Vertical gene transfer is the more familiar form of inheritance: from parents to offspring.) The flow of viral genes into cellular genomes has been "overwhelming," Forterre and a co-author have argued, and may help explain some great evolutionary transitions, such as the origin of DNA, the origin of the cell nucleus in complex creatures, the origin of cell walls, and maybe even the divergence of those three great limbs on the tree of life.

IN THE OLDEN DAYS, the days before COVID-19, engrossing discussions with scientists sometimes happened in person, not by Skype. Three years ago, I flew from Montana to Paris because I wanted to talk with a man about a virus and a gene. The man was Thierry Heidmann, and the gene was syncytin-2. He and his group had discovered it by screening the human genome—all 3.1 billion letters of code—to find stretches of DNA that looked like the kind of gene a virus would use to produce its envelope. They found about 20.

"At least two proved to be very important," Heidmann told me. They were important because they had the capacity to perform functions essential to human pregnancy. Those two were syncytin-1, which was first discovered by other scientists, and syncytin-2, which he and his group found. How these viral genes became part of the human genome, and to what purposes they have become adapted, are aspects of a remarkable story that begins with the concept of human endogenous retroviruses.

A retrovirus is a virus with an RNA genome that operates backward from the usual direction (hence retro). Instead of using DNA to make RNA, which then serves as a messenger sent to the 3D printer to make proteins, these viruses use their RNA to make DNA and then integrate it into the genome of the infected cell. HIV, for instance, is a retrovirus that infects human immune cells, inserting its genome into the cell genome, where it may lie dormant. At some point, the viral DNA gets activated, becoming a template for production of many more HIV virions, which kill the cell as they come exploding out.

Here's the big twist: Some retroviruses infect reproductive cells—the cells that produce eggs or sperm—and in doing that, they insert their DNA into the heritable genome of the host. Those inserted stretches are "endogenous"

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nn and I broke for lunch and then
or another two hours. Finally, my
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nes are not only *our* genes," he said.
are also retroviral genes."

RIBUTION of that retrovirus, giving
n-2, is only one instance of a grand
nother is the gene *ARC,* expressed in response to neuronal activity in mammals and flies. It closely resembles a retroviral gene that codes for a protein capsid. Recent research by several teams, including one led by Jason Shepherd at the University of Utah, suggests that *ARC* plays a key role in storing information within neural networks. Another word for that: memory. *ARC* seems to do it by packaging information derived from experience (embodied as RNA) into little protein sacs that carry it from one neuron to another.

And at the Stanford University School of Medicine, Joanna Wysocka, along with a group of colleagues, has found evidence that viral fragments produced by another human endogenous retrovirus, known as *HERV-K,* are present within human embryos at the earliest stage and might play some positive role in protecting the embryo from viral infection, or in helping control fetal development, or both. Further, her group has focused on a particular transposon that seems to have entered the human genome as a sort of prologue section of *HERV-K,* then found ways of copying itself and bouncing to other parts of the genome, so that it's now present in 697 scattered copies. Those copies seem to help turn on almost 300 human genes.

"To me what is really mind-boggling," Wysocka said, "is that HERVs are about 8 percent of the human genome," a portion of our being that is essentially "the graveyard of previous retroviral infections." It's even more boggling to contemplate how, as Wysocka put it, "our history of past retroviral infections is continuing to shape our evolution as a species."

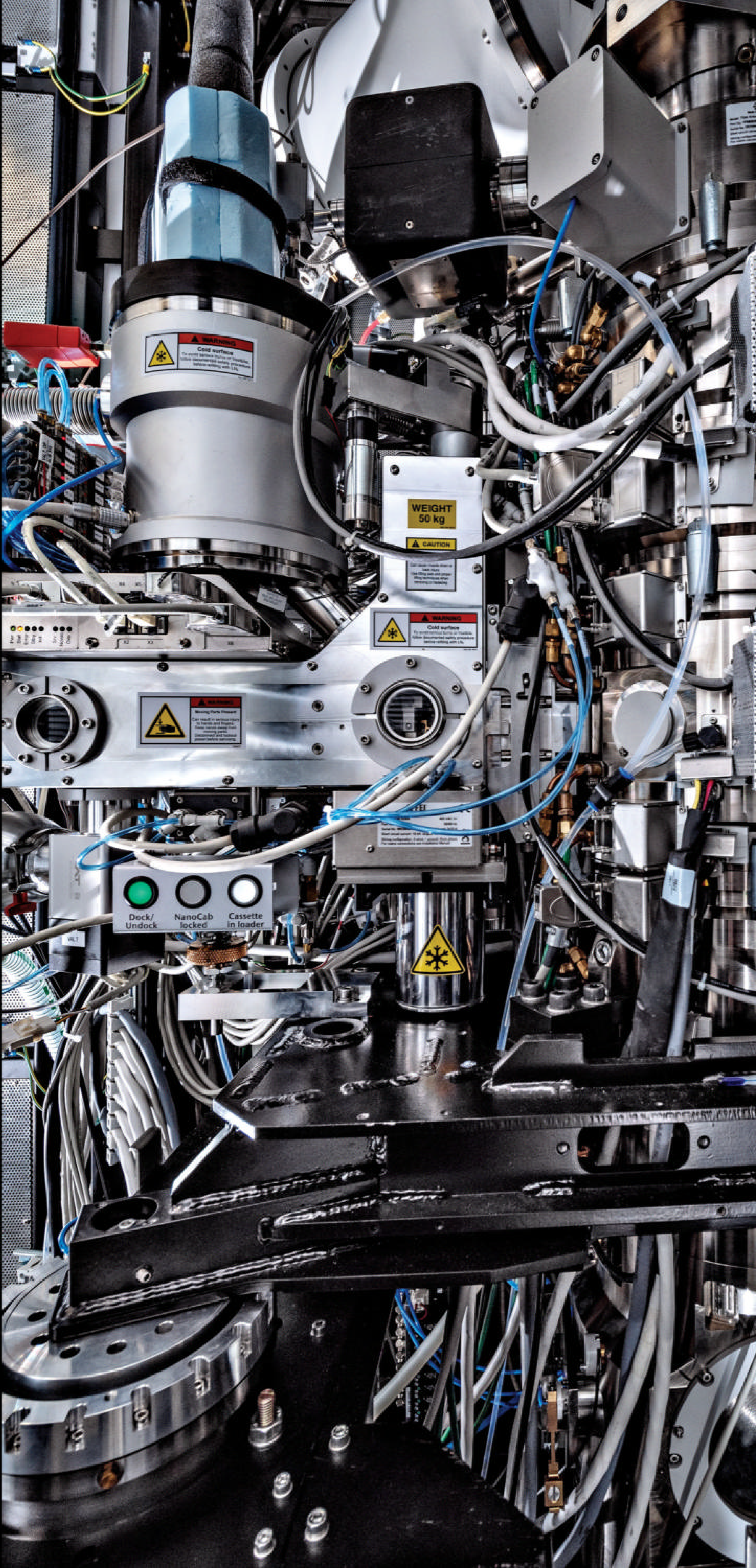
If 8 percent of your genome and mine is retroviral DNA, and half is transposons, then maybe the very notion of human individuality (let alone human supremacy) is not as solid as we like to believe.

THE DOWNSIDE of such evolutionary agility, of course, is that viruses can sometimes switch hosts, tumbling from one kind of creature into another and succeeding as pathogens in the unfamiliar new host. That's called spillover, and it's how most new human infectious diseases arise—with viruses acquired from a nonhuman animal host.

In the original host—known to science as a reservoir host—a virus may have abided quietly, at low abundance and low impact, for thousands of years. It may have reached an evolutionary accommodation with the reservoir host, accepting security in exchange for causing no trouble. But in a new host, such as a human, the old deal doesn't necessarily hold. The virus may explode in abundance, causing discomfort or misery in that first victim. If the virus not only replicates but also manages to spread, human to human, among a few dozen other individuals, that's an outbreak. If it sweeps through a community or a country, that's an epidemic. If it encircles the world, it's a pandemic. So now we're back to SARS-CoV-2.

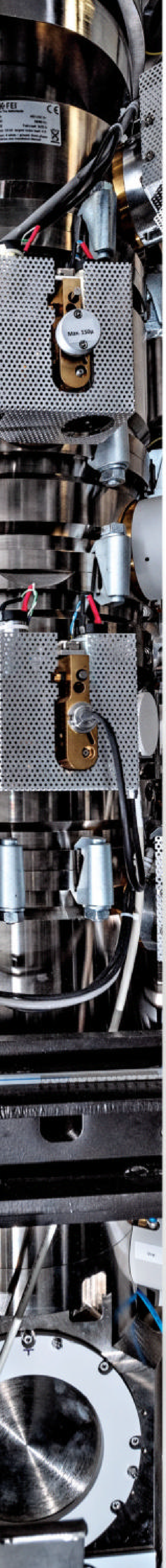
Some types of viruses are more likely to cause pandemics than others. Near the top of the list of the most worrisome candidates are coronaviruses, because of the nature of their genomes, their

The flow of viral genes into cellular genomes has been "overwhelming," scientists argue, and may help explain some great evolutionary transitions, such as the origin of DNA, the cell nucleus, and cell walls, and even the divergence of the three great domains of life.



The inner workings of a cryogenic transmission electron microscope (right) showcase its technological complexity. The instrument, which can create images of viruses down to near atomic level in three dimensions, revealed the now familiar spiky structure of SARS-CoV-2. A monitor used with the microscope (far right) displays a cross section of the virus and a three-dimensional computational model.

LEO HILLIER, MRC LABORATORY OF MOLECULAR BIOLOGY; ZUNLONG KE, LESLEY MCKEANE, AND JOHN BRIGGS, MRC LABORATORY OF MOLECULAR BIOLOGY (MONITOR IMAGES)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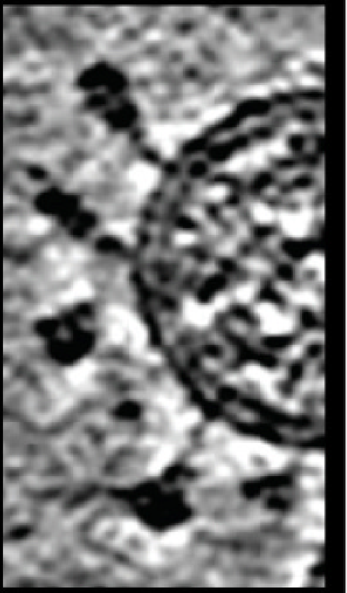
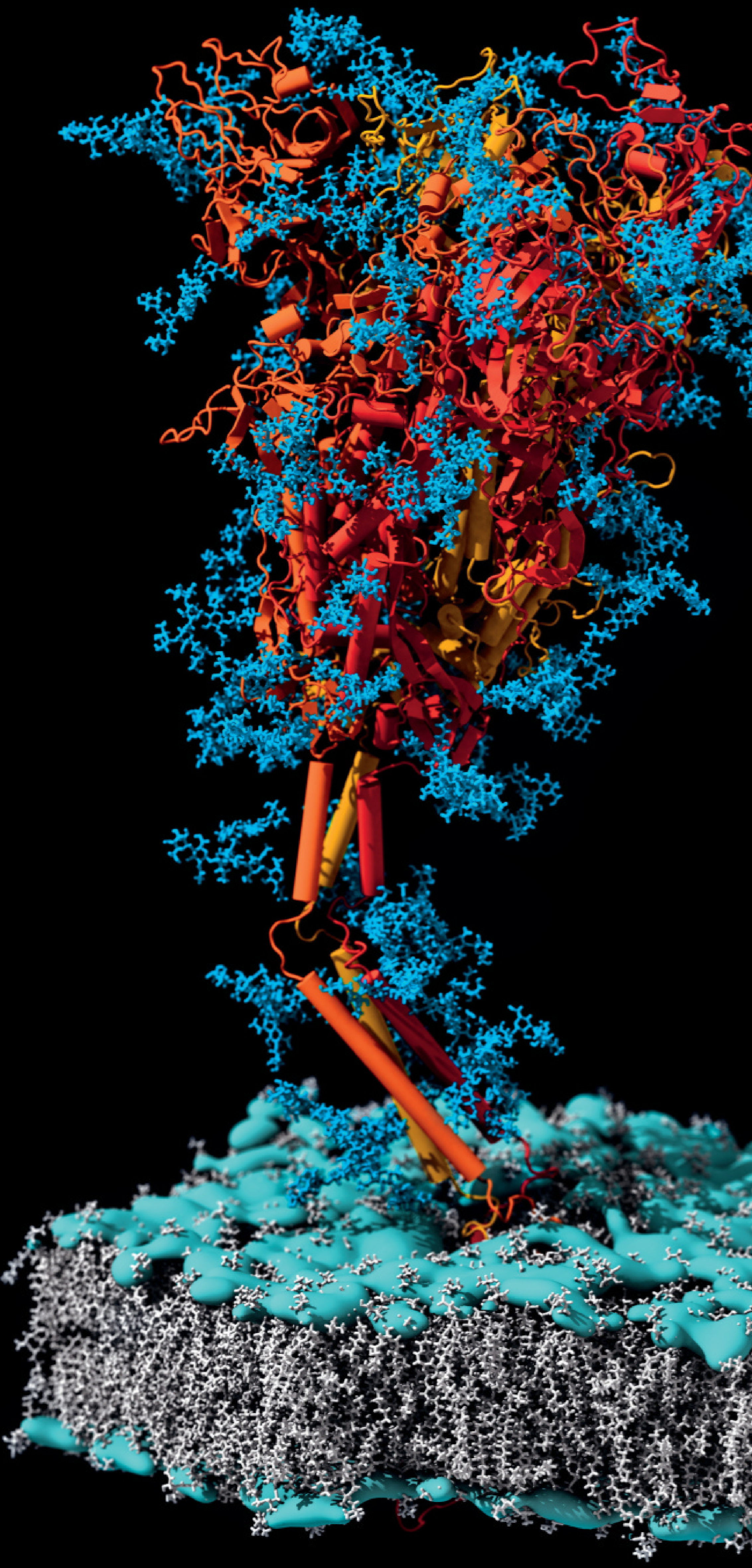
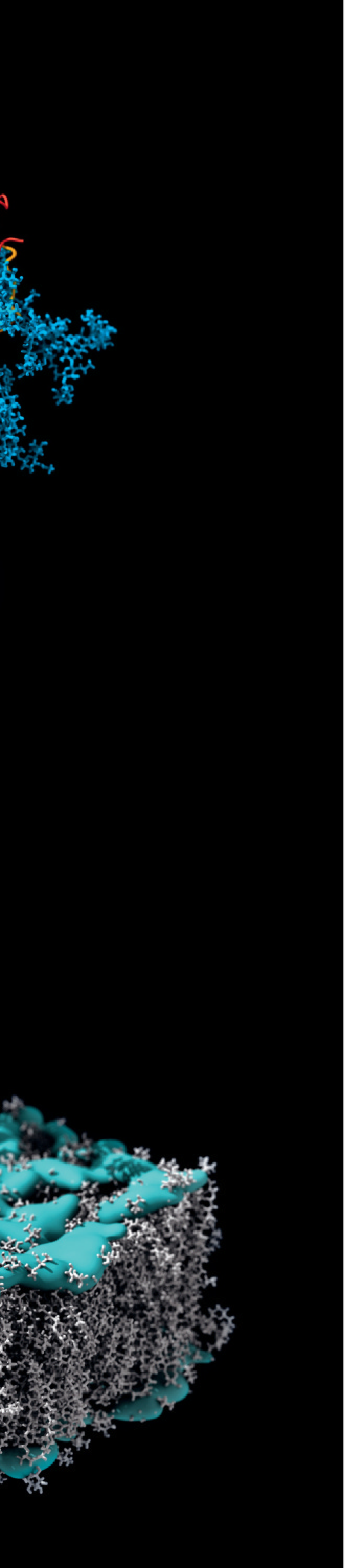




A slice of a reconstruction of SARS-CoV-2 from cryo-electron tomography (above) shows that the spikes protrude at odd angles. These spikes have three joints—hip, knee, and ankle—that allow them to flop around, most likely to increase the odds of attaching to a cell. A molecular model at atomic resolution (right) shows the proteins making up the spike, with identical chains indicated by red, orange, and yellow. They are shielded by chains of glycans—sugarlike molecules colored blue—that hide the spike from human antibodies that could destroy it. Understanding the spike's structure is key to designing effective vaccines.

MATEUSZ SIKORA, MAX PLANCK INSTITUTE OF BIOPHYSICS (RENDERING OF MOLECULAR MODEL); COURTESY BEATA TUROŇOVÁ AND MARTIN BECK, EUROPEAN MOLECULAR BIOLOGY LABORATORY (SARS-COV-2 SLICE)



capacity to change and evolve, and their history of causing serious human disease, such as SARS (severe acute respiratory syndrome) in 2003 and MERS (Middle East respiratory syndrome) in 2015. So when the phrase "novel coronavirus" began to be used to describe the new thing causing clusters of illness in Wuhan, China, those two words were enough to make disease scientists around the world shudder.

Coronaviruses belong to an infamous category of viruses, the single-stranded RNA viruses, that includes influenzas, Ebola viruses, rabies, measles, Nipah, hantaviruses, and retroviruses. They are infamous partly because a single-stranded RNA genome is subject to frequent mutation as the virus replicates, and such mutation supplies a richness of random genetic variation upon which natural selection can work.

Coronaviruses, though, evolve relatively slowly for RNA viruses. They carry fairly long genomes—the SARS-CoV-2 genome runs to about 30,000 letters—but their genomes change less quickly than some others because they have a proofreading enzyme to correct mutations. Yet they are also capable of a trick called recombination, in which two strains of coronavirus, infecting the same cell, swap sections of their genomes and give rise to a third, hybrid strain of coronavirus. That may be what happened to create the novel coronavirus, SARS-CoV-2.

The ancestral virus probably resided in a bat, possibly a horseshoe bat, belonging to a genus of small, insectivorous creatures with horseshoe-shaped noses, which commonly carry coronaviruses. If recombination did occur, adding some crucial new elements from a different coronavirus, this could have happened in a bat or possibly in another animal. (Pangolins have been suggested; other species could also be candidates.) Scientists are exploring these possibilities and others by sequencing and comparing genomes of the viruses found in various potential hosts. All we know for now is that SARS-CoV-2 as it exists today in humans is a subtle virus capable of further evolution.

SO VIRUSES GIVE and viruses take away. Maybe the reason they are difficult to place on the tree of life is that life's history, after all, isn't quite shaped like a tree. The arboreal analogy is just our traditional way of illustrating evolution, made canonical by Charles Darwin. But Darwin, great as he was, knew nothing about horizontal gene transfer. In fact, he knew nothing about genes. He knew nothing about viruses. Everything is very complicated, we realize now. Even viruses, which seem so simple at first glance, are very complicated. And if seeing them in all their complexity gives us humans a clearer vision of the tangled connectedness of the natural world, if reflecting upon our own viral contents takes away some of our sublime detachment, then I leave it to you to say whether those are benefits or harms.

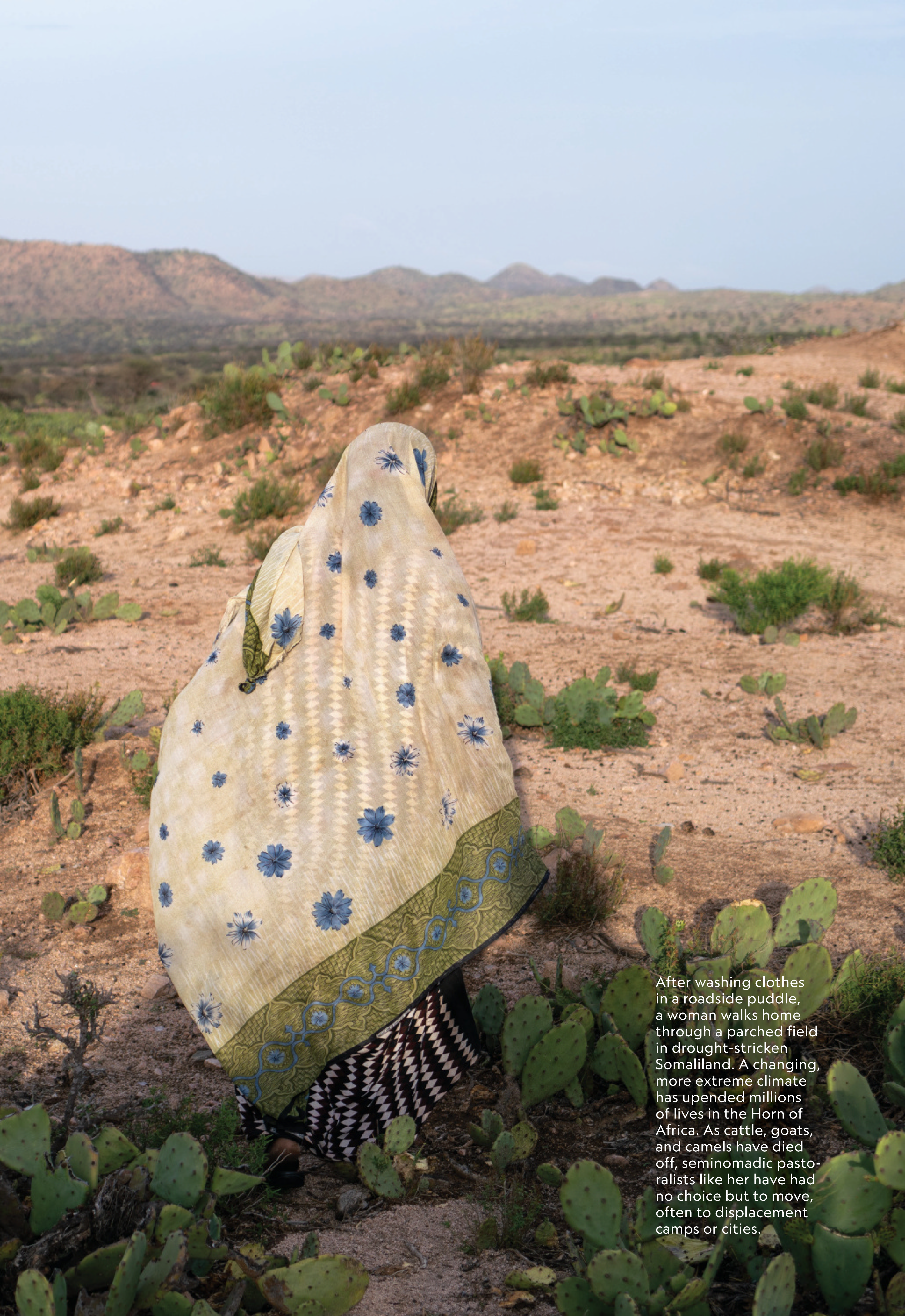
David Quammen's 16 books include *Spillover: Animal Infections and the Next Human Pandemic,* which foretold COVID-19. **Craig Cutler** is an artist and photographer who specializes in still life and environmental portraiture, striving to tell a story in each image.

WOMEN ON THE MOVE

OUT OF FEAR, HOPE, OR DESPERATION, MILLIONS OF WOMEN AROUND THE WORLD MIGRATE EACH YEAR IN SEARCH OF NEW LIVES.

BY **AURORA ALMENDRAL**

PHOTOGRAPHS BY **THE EVERYDAY PROJECTS**



After washing clothes in a roadside puddle, a woman walks home through a parched field in drought-stricken Somaliland. A changing, more extreme climate has upended millions of lives in the Horn of Africa. As cattle, goats, and camels have died off, seminomadic pastoralists like her have had no choice but to move, often to displacement camps or cities.

R

Raxma Xasan Maxamuud never wanted to leave her home in Somaliland. But a relentless cycle of droughts turned rivers to dust and dried up the grasses her livestock depended on. In Honduras, violence drove Kataleya Nativi Baca, a transgender woman, on a perilous journey to the United States border.

Women make up about half of those who migrate internationally and within their own countries. Some are pulled by the promise of a better future, but for those who face famine or danger in their home countries, migration is a gamble for their very survival.

For this story, photographers with The Everyday Projects—a global network with a mission to challenge stereotypes by presenting diverse perspectives—explore how hardship and obligation, violence, poverty, climate change, and other forces undermine women's lives, spurring them to make life-changing journeys.

The International Organization for Migration reported that 272 million people—130 million of them women—were living in a country not of their birth in 2019. More than 60 percent of those migrants live in Asia and Europe. Most international migration, however, is regional, with movement to and between countries in the Middle East, North Africa, and sub-Saharan Africa growing fastest.

In recent decades women increasingly have migrated to wealthy countries to become breadwinners themselves, rather than to join family members. They're taking jobs in child- and eldercare and domestic work, as well as manufacturing and agriculture—a shift described as "the feminization of migration." Migrant women living abroad are more likely to be overqualified for these jobs and earn less than men, and they send more of their incomes to families back home.

For women escaping violence or poverty, the clandestine routes they take increase their vulnerability to sex trafficking, assault, and rape. And for women going to countries with weak laws, or for women who are undocumented, securing basic rights may be impossible.

Forced migration of refugees and asylum seekers rose by an average of 8 percent a year from 2010 to 2017, compared with less than 2 percent for international migration. Of the 33.8 million people forced to migrate abroad in 2019, nearly half were women. That year another 33.4 million people, more than half of them women, were forced to move within their own countries, 75 percent of them because of natural disasters.

The World Bank estimates that in 2020, the COVID-19 pandemic led to an unprecedented 20 percent drop in global remittances to home countries. Fear, anger, and poverty are inflaming resentments and xenophobia, and migrants are often scapegoated as disease vectors or blamed for social ills exacerbated by the pandemic.

On the following pages, we tell the stories of five women migrants that illustrate facets of the relocation experience: the decision to leave; the hope and hardship of the journey; the arrival in unfamiliar circumstances; the adjustment to a new life; and the realization that however demanding or traumatic it is to uproot oneself from home, migration can be a path to freedom.

Aurora Almendral is a journalist based in Southeast Asia whose previous story for the magazine was about migration culture in the Philippines.

Hope and Resilience

In recent years millions of women have left their homes, traveling between villages and cities, and across borders, in pursuit of new lives. COVID-19 slowed the flow, but the pressures to migrate—violence, oppression, drought, poverty—persist. The hope for change drives many women to embark on journeys that can range from joyous to tragic.

The Everyday Projects network uses photography to challenge stereotypes and amplify storytelling worldwide. Eight women photographers came together to document the impact of migration on women around the globe.

This story was created with additional support from the **National Geographic Society.**

For a companion curriculum developed by the **Pulitzer Center** for middle and high schoolers, visit *pulitzercenter.org/womenonthemove*.

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MOVE — OR DIE | After drought killed her livestock, a Somali pastoralist has no choice but to join thousands of others marking time in a displaced persons camp.

02

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THE JOURNEY | For a transgender asylum seeker, the passage across Mexico to the United States border brims with anticipation. Then despair sets in.

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THE CONTRACT | A Vietnamese woman seeks financial security for her family through a brokered marriage to a man in affluent Singapore.

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FINDING PEACE | A Rohingya woman whose family fled violence and oppression in a village in Myanmar enjoys safety and freedom in Sydney.

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NEW CHOICES | A young woman born into the Afghan diaspora in Pakistan leaves home to find more freedom through education.

ONLINE

ZIMBABWE ▶ SOUTH AFRICA

COVID-19 compounds the hardships of thousands of women who migrate to South Africa from neighboring countries.

KYRGYZSTAN ▶ RUSSIA

For women drawn to Russia from Central Asian countries by the promise of jobs, xenophobia stalks their daily lives.

YEMEN ▶ THE NETHERLANDS

A photographer who fled war-torn Yemen yearns for her family. "There will be a time when I will reunite with them."

natgeo.com/womenonthemove

01 **SOMALIA**

PHOTOGRAPHS BY **NICHOLE SOBECKI**

Move— or Die

SHE LOST NEARLY EVERYTHING WHEN DROUGHT KILLED HER LIVESTOCK. NOW SHE BIDES HER TIME IN A CAMP FOR DISPLACED PEOPLE.

The sheep were the first to start dying. Unable to find enough grass to eat, they'd grown thin and listless, their bleats fading. "They were just dying around us like something poisoned," Raxma Xasan Maxamuud says. Pastoralists in the village of Haya, in central Somaliland, an unrecognized, self-declared state within Somalia, Raxma and her family raised 300 goats and sheep and 20 camels. Within four weeks of drought in 2016, all their animals had died.

Seminomadic Somali pastoralists, who tally the passage of years by the regular arrival of the rains, began to notice that during the past 20 years the rains were erratic, no longer aligning with other rhythms of life, such as when their animals gave birth. "If anybody still doubts climate change," says Sarah Khan, head of the Hargeysa suboffice of the United Nations High Commissioner for Refugees, "they just have to come here."

Raxma says she's about 36 years old. She was born in the year her community named *biyo badan,* "a lot of water." In her lifetime, severe droughts used to occur about twice a decade, but

A young camel tugs at Cadar Maxamed's hijab in Xinjiinle, in northern Somaliland. The camel was named Baruud—"tough"—because its mother survived years of drought, unlike most of Cadar's animals. Camels and other livestock are the basis of pastoralists' wealth in the region.

Looking skyward, a woman watches a swarm of locusts in central Somaliland. Weather extremes have led to the largest outbreak of crop-destroying desert locusts in 22 years.

punishing drought in 2016 and 2017 destroyed an estimated 70 percent of Somaliland's pastoral economy, the primary industry. Rain-fed rivers and lakes that had sustained generations of pastoralists disappeared. In Haya in 2016, the wells went dry for the second time in five years.

The town hired trucks to bring water in from another city, but mostly "we felt thirsty," Raxma says. Villagers didn't wash their clothes. And unlike during the year of plenty Raxma was born into, they didn't name the bad years, hoping those times would be forgotten. "The life we had before was like living in a castle," Raxma says. "We sold goats and had meat and butter. We didn't need anybody's help. We used to help others because we had too much."

Somali pastoralists measure wealth not by what they can buy but by the size of their herds. Losing your livestock is akin to having your house burn down, your car stolen, and your bank account emptied on the same day.

In Haya the smell of death from thousands of rotting carcasses hung in the air, but for three months, as the drought of 2016 deepened, Raxma's family held on. Families with surviving camels shared milk with those whose herds had died. As food dwindled, adults saved the largest portions for the youngest children. Diarrhea spread, Raxma says, and people feared for their lives. With all their animals now dead, the villagers pooled their money and rented a truck to take them to an IDP (internally displaced persons) camp near Burco, in central Somaliland.

The World Bank estimates that by 2050, 143 million people in sub-Saharan Africa, South Asia, and Latin America will be forced to move within their own countries because of climate conditions. Today Raxma and as many as 600,000 people in Somaliland are stranded in camps, dependent on humanitarian aid to eat and drink.

ABOVE

Raxma Xasan Maxamuud, 36, has been stranded for three years at a camp for displaced people outside Burco, Somaliland. She longs for the abundance and happiness of her former life as a pastoralist, before her family's drought-stricken herds died.

LEFT

Sisters Maryan Yusuf, 15, and Xaawa Yusuf, 12, study Arabic at their family compound in northern Somaliland under the eye of their mother, Caasha Jaamac (at center), 40. The family has had to rebuild twice after losing everything, first to drought and later to a cyclone. Many Somalis look to education to prepare their children for a future in which their traditional pastoral life might no longer be viable.

Raxma hasn't given up hope. She named her youngest daughter, who was born in the camp, Barwaaqo, a word that evokes prosperity, abundance, and the happiness felt when the herds are healthy, the rains plentiful, and the lands green. Raxma lost nearly everything, but her daughter's name is an expression of gratitude that her family's survival is its own kind of wealth. *—AA*

Nichole Sobecki is a photographer based in Nairobi, Kenya, who focuses on humanity's connection to the natural world. Follow her on Instagram *@nicholesobecki*. **Asma Dhamac** contributed reporting in Somaliland.

As many as 600,000 people in Somaliland are STRANDED in camps, dependent on humanitarian aid to eat and drink.

02 HONDURAS ▸ MEXICO

PHOTOGRAPHS BY **DANIELLE VILLASANA**

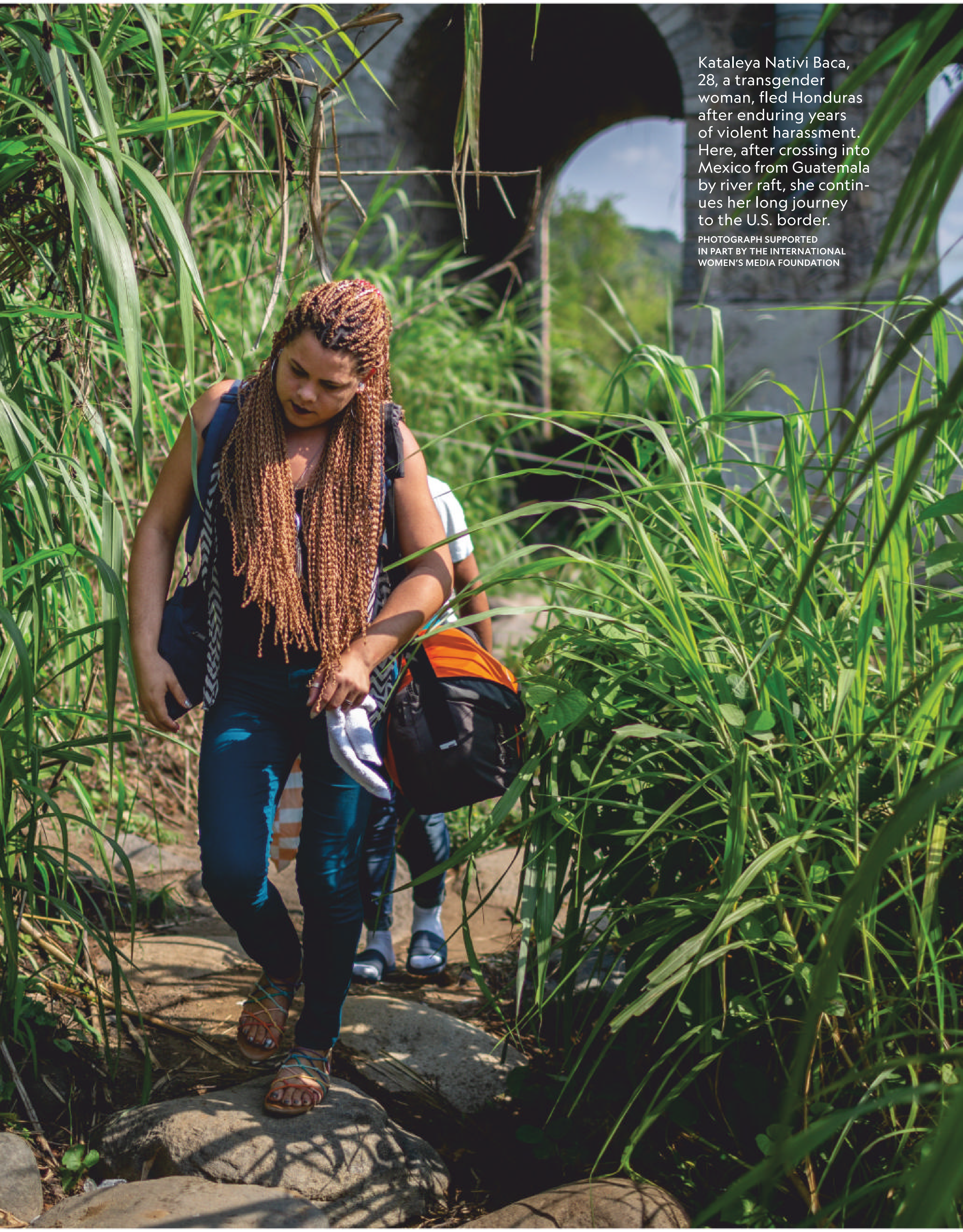
The Journey

FLEEING DANGER AT HOME, SHE BRAVED A PERILOUS TRIP TO THE U.S.-MEXICO BORDER—ONLY TO FIND MORE VIOLENCE AND UNCERTAINTY.

Before Kataleya Nativi Baca left Tapachula, Mexico, she called her sister from the apartment she was sharing with two other migrants from Central America. “Tomorrow I’m going to be a lot farther away,” she said.

Kataleya, 28, a transgender woman, was a pariah in her hometown of San Pedro Sula, in Honduras. Her mother rejected her. Her brother beat her. In a country where spiraling violence is fueled by machismo—exaggerated expressions of masculinity—hundreds of lesbian, gay, bisexual, transgender, and intersex people are harassed, often violently. A network of rights groups found that more than 1,300 of these individuals have been killed in Latin America and the Caribbean since 2014, 86 percent in Colombia, Mexico, and Honduras. For many, braving the dangerous journey to seek asylum in the U.S. is preferable to facing dangers at home.

Tapachula, a border city in southern Mexico, is a hub for migrants from Central America, the Caribbean, and Africa. Kataleya spent four months there until she received a visa to transit



Kataleya Nativi Baca, 28, a transgender woman, fled Honduras after enduring years of violent harassment. Here, after crossing into Mexico from Guatemala by river raft, she continues her long journey to the U.S. border.

PHOTOGRAPH SUPPORTED IN PART BY THE INTERNATIONAL WOMEN'S MEDIA FOUNDATION

Samanta Hilton, Alexa Smith, and Escarle Lovely relax in their hometown of San Pedro Sula, Honduras. Latin America is the world's deadliest region for transgender women like them.

PHOTOGRAPH SUPPORTED IN PART BY THE INTERNATIONAL WOMEN'S MEDIA FOUNDATION

through Mexico to Tijuana, at the U.S. border.

Before boarding the bus, Kataleya said bittersweet goodbyes to people she passed on the street, the security guard at her favorite fast-food spot, her roommates—strangers who'd become friends in the shared challenge of escape. "Finally I'm out of Tapachula," she said.

The bus was full—mostly men, women, and children dreaming of a new life. The driver flipped the air conditioner on and off to save gas. Cell phones hung from shared power strips overhead. The riders made grainy video calls.

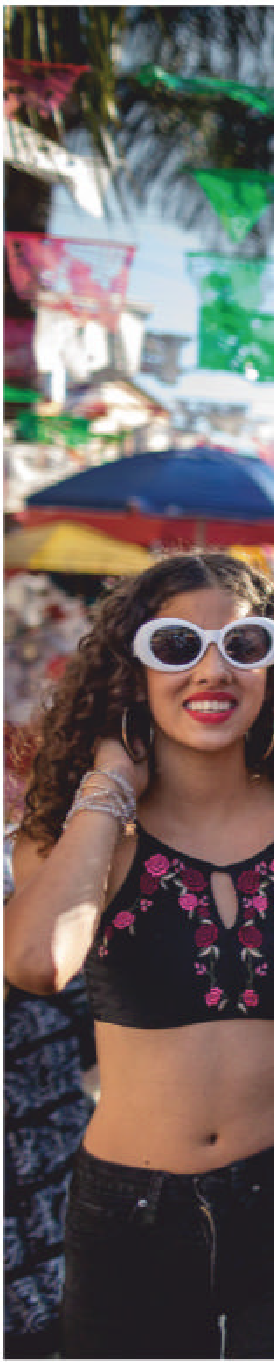
Immigration officers soon stopped the bus to check the passengers' papers—the first of 20 stops and checkpoints that set a rhythm of disruption and anxiety for the next 72 hours and 2,500 miles. Many migrants who can't secure transit papers through Mexico hitchhike or walk to avoid authorities and the risk of jumping a train. They're exposed to gang violence, sexual assault, extortion, recruitment from organized crime, and kidnapping. Kataleya was lucky: She had papers.

By the third day, the smell from the toilet was so bad that people clapped cloths over their noses each time the door opened. Backpacks and purses bulged with rumpled clothes and toiletries. Kataleya cleaned herself with wet wipes and reapplied her lipstick. Hours out of Tijuana, the bus roused in a commotion. The migrants pressed against the windows, squinting at a metal line snaking across the expanse of yellow grassland—the U.S. border fence.

In Tijuana, Kataleya was given a number to have her asylum case heard: 4,050. At the time, the authorities were processing 2,925. Six months later, and roughly two weeks before her number was supposed to come up, the U.S. government closed the border to immigration because of the COVID-19 pandemic, halting asylum claims.

Facing uncertainty and violence at the border in Mexico, and rejection at home, Kataleya finds that the hope that propelled her on her journey to the U.S. has been replaced with a dread in the pit of her stomach she can't escape. Her limbo has included being robbed and beaten in shelters for LGBTQ migrants. At other times, she's depended on support from different men. Despair has set in. "From morning to night," she says, "everything fell apart." *—AA*

Danielle Villasana is a photojournalist and National Geographic explorer whose work focuses on human rights, gender, and health. Follow her on Instagram *@davillasana*.



ABOVE

Kataleya spent four months in the southern Mexican city of Tapachula, where she obtained a visa that enabled her to travel the 2,500 miles north to the U.S. border by bus instead of having to walk or hitchhike.

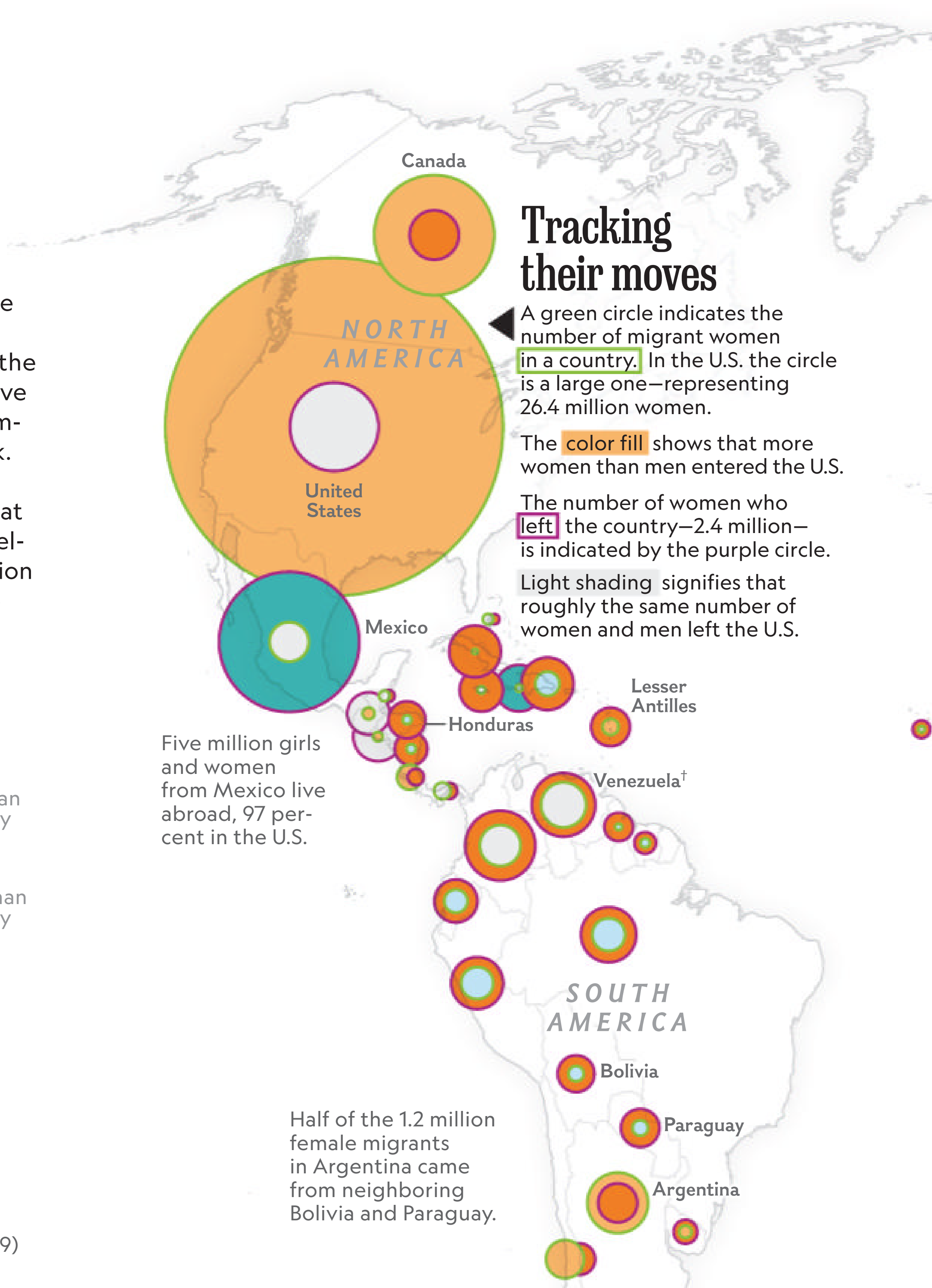
RIGHT

Tijuana marked the end of Kataleya's journey through Mexico, and the start of her appeal for asylum. A months-long wait became indefinite for Kataleya (in pink shirt) when the U.S. closed the border to all immigrants in March 2020 because of the COVID-19 pandemic.

The hope that propelled Kataleya on her journey to the U.S. has been replaced with a DREAD she can't escape.

Crossing Borders

War, famine, and a search for opportunity long have spurred men and women to leave their home countries, as this map of millions living abroad in 2019 illustrates. For the past two decades, women increasingly have been traveling independently of other family members, usually for education or work. In destination countries, women migrants' participation in the labor force exceeds that of nonmigrant women by 15 percent. Traveling alone compounds the risk of exploitation and gender-based violence, but often the decision to leave is not a choice.



Tracking their moves

A green circle indicates the number of migrant women in a country. In the U.S. the circle is a large one—representing 26.4 million women.

The color fill shows that more women than men entered the U.S.

The number of women who left the country—2.4 million—is indicated by the purple circle.

Light shading signifies that roughly the same number of women and men left the U.S.

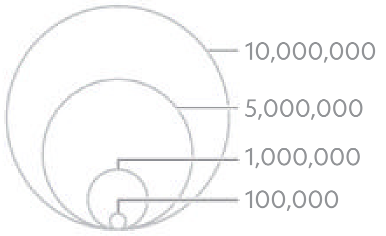
Five million girls and women from Mexico live abroad, 97 percent in the U.S.

Half of the 1.2 million female migrants in Argentina came from neighboring Bolivia and Paraguay.

GENDER GAP IN MIGRATION

Destination			Origin
More women than men moved here	●	●	**More women** than men moved away
About the same	○	○	About the same
Fewer women than men moved here	●	●	**Fewer women** than men moved away

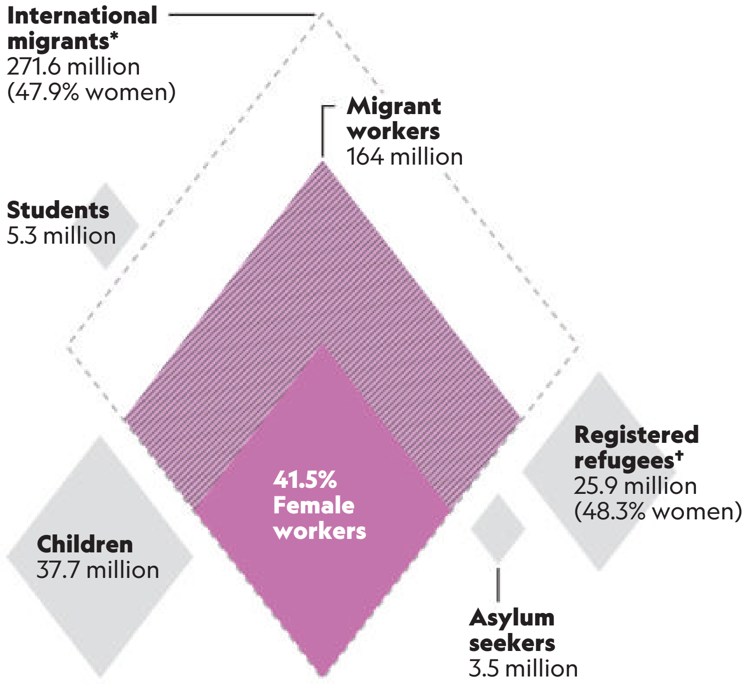
FEMALE MIGRANTS



Number living outside their birth country (2019)

MOVING FOR WORK

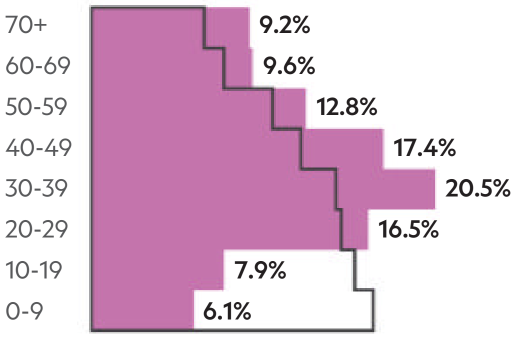
Migrant workers accounted for almost two-thirds of the 271.6 million people living in foreign countries in 2019. Nearly 48 percent of international migrants were women.



WORKING WOMEN

Most women who leave home for another country are 20 to 50 years old.

■ Female international migrants
☐ Female world population



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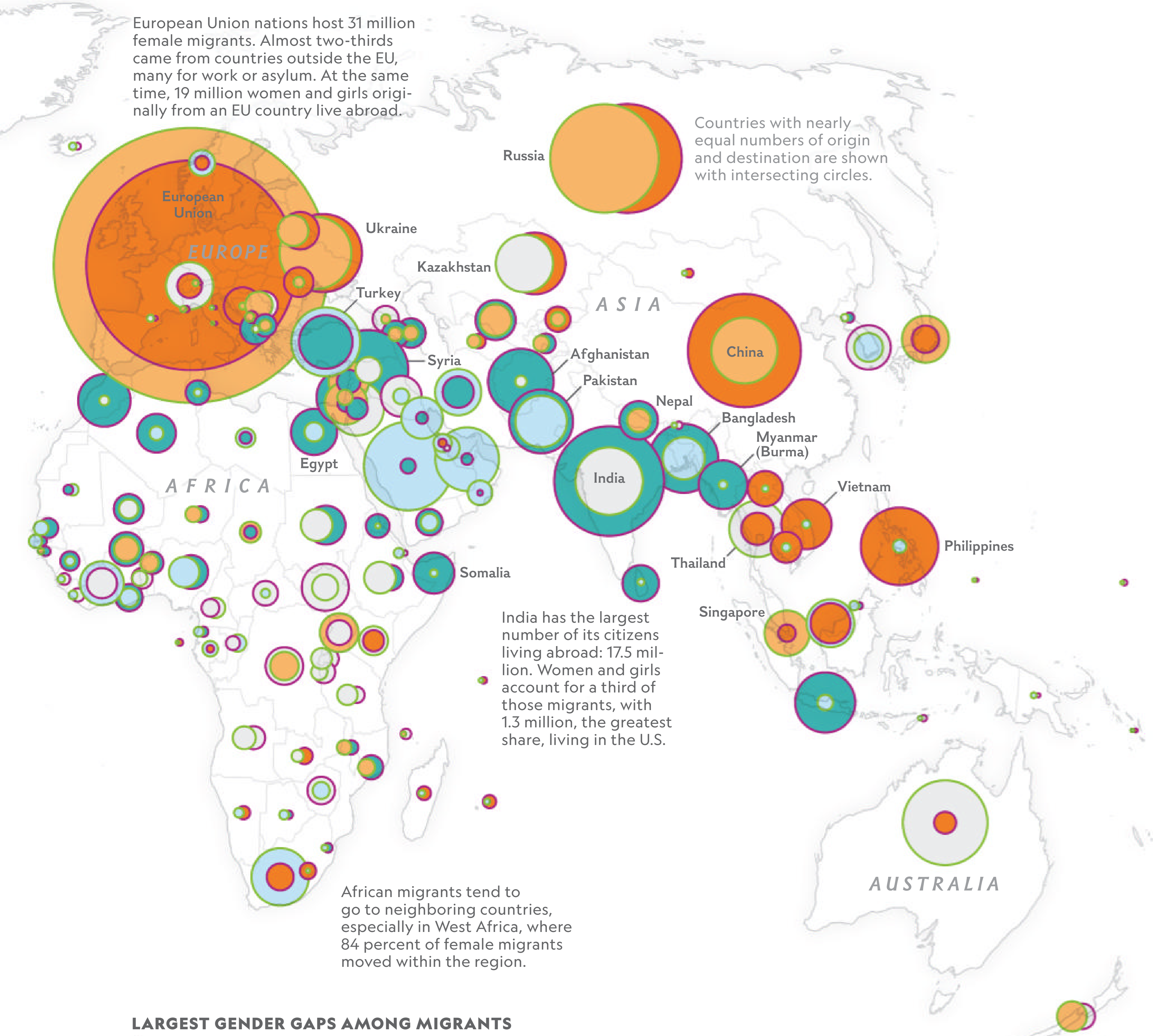
*Categories are not mutually exclusive.
†An additional 3.6 million Venezuelans have been displaced abroad but are not counted as refugees.



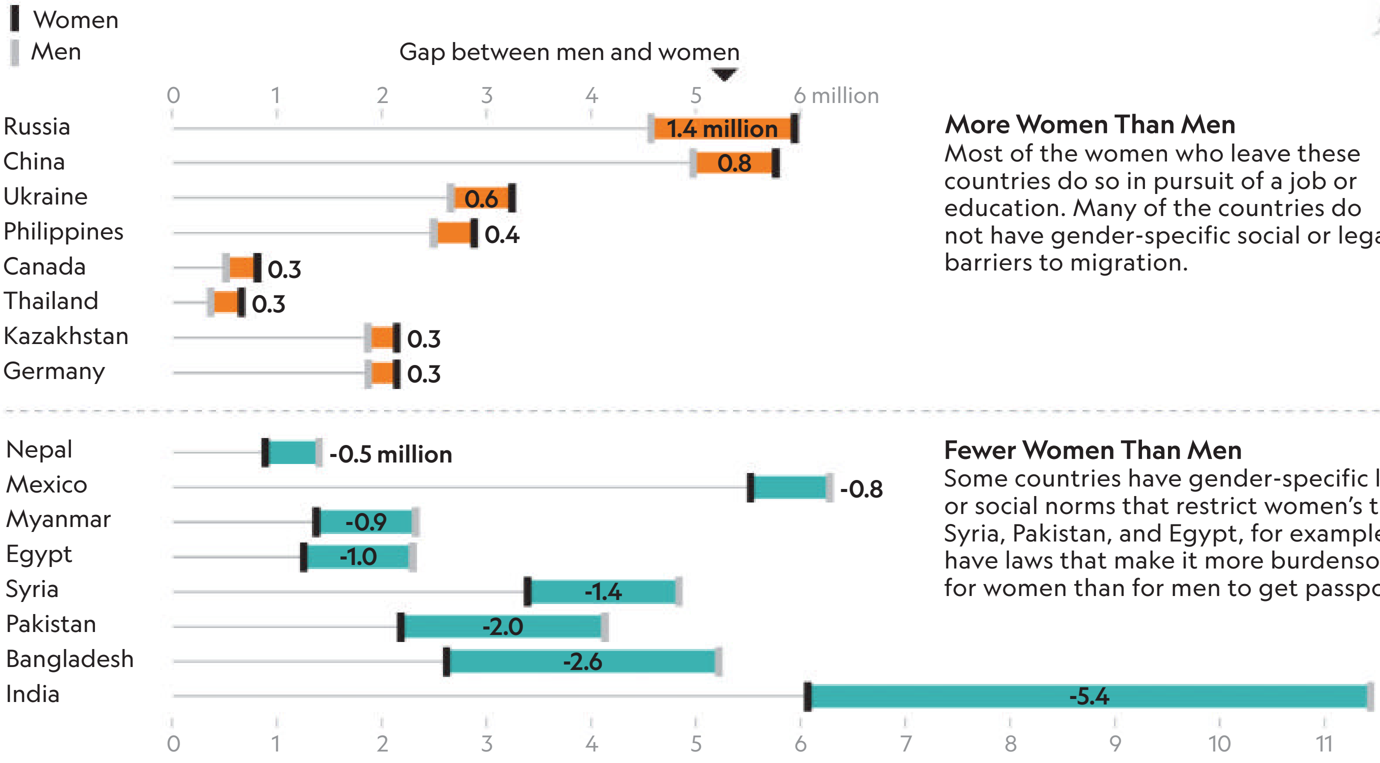
European Union nations host 31 million female migrants. Almost two-thirds came from countries outside the EU, many for work or asylum. At the same time, 19 million women and girls originally from an EU country live abroad.

Countries with nearly equal numbers of origin and destination are shown with intersecting circles.

India has the largest number of its citizens living abroad: 17.5 million. Women and girls account for a third of those migrants, with 1.3 million, the greatest share, living in the U.S.

African migrants tend to go to neighboring countries, especially in West Africa, where 84 percent of female migrants moved within the region.

LARGEST GENDER GAPS AMONG MIGRANTS



More Women Than Men
Most of the women who leave these countries do so in pursuit of a job or education. Many of the countries do not have gender-specific social or legal barriers to migration.

Fewer Women Than Men
Some countries have gender-specific laws or social norms that restrict women's travel. Syria, Pakistan, and Egypt, for example, have laws that make it more burdensome for women than for men to get passports.

CHRISTINE FELLENZ AND MONICA SERRANO, NGM STAFF; KELSEY NOWAKOWSKI. SOURCES: CLARE MENOZZI, UN POPULATION DIVISION; ILO; IOM; UNESCO; UNHCR

03 **VIETNAM ▸ SINGAPORE**
PHOTOGRAPHS BY **AMRITA CHANDRADAS**

The Contract

DETERMINED TO FIND FINANCIAL SECURITY, SHE RISKED LEAVING HER HOME IN RURAL VIETNAM FOR A BROKERED MARRIAGE TO A MAN IN A WEALTHIER COUNTRY.

This Vietnamese woman—who married a Singaporean man 11 years ago and has two children by him—is in an unhappy marriage. She's afraid to divorce him because she, like other marriage migrants, depends on her husband to renew her residency, and she risks losing custody of her children.

On Ngoc Tuyen's wedding day she was surrounded by strangers. She sat on a wooden bench in Singapore's botanical garden, in a red dress with black lace trim and a headband with beaded daisies. She'd met the groom two months earlier, and his family only after she arrived 16 days before. A marriage broker translated the ceremony into Vietnamese, and they sealed their commitment with a stiff kiss on the lips. After a flurry of paper-signing, Tuyen's marriage was official. "It's such a good start," Tuyen says. "I want to work soon."

Tuyen is a marriage migrant—one of tens of thousands from Vietnam during the past decade, most of them women. It often starts with marriage brokers who alert women in villages and provincial towns about men visiting from South Korea, China, Taiwan, Singapore. This is how Tuyen, 34, met Tony Kong, 45. His photo popped up on a broker's Facebook feed, with an address in Ho Chi Minh City and a date when he'd be viewing and interviewing potential wives. The terms are clear: Women come prepared to negotiate stipends for themselves and their families,

and the men state their salaries. In exchange for their beauty, youth, and companionship, the women want financial stability—and in Tuyen's case, the chance to work and send money home to her family. Remittances are crucial in poor, rural parts of Vietnam.

"It's not about love," says Mark Lin, a matchmaker and proprietor of the Singaporean marriage agency True Love Vietnam Bride. Asked if his male clients are handsome, Lin grimaces before arriving at a diplomatic answer: "It depends." Lin knows that his industry trades on economic disparity. In Singapore, the average annual income is $92,000; in Vietnam, it's $7,750. Whatever flaws prevent his clients from finding Singaporean women to marry, at least they have more money than their Vietnamese counterparts.

Tuyen asked Tony for a monthly stipend of $370, which he negotiated to $220, the amount she'd earned working at a food stall back home. It's not enough to support her family, but she's hoping that if her work permit is approved, she'll find a job at a nail salon and be able to send money back to her parents and her five-year-old son.

For a migrant wife to stay and work in Singapore, she must first apply for a long-term visit pass, which is renewed by her husband every one to two years. If he doesn't, the woman loses not only her papers but also possibly any children born from the marriage. Courts routinely grant custody to the Singaporean parent, as children benefit from being Singaporean citizens. Their mothers, who depend on their husbands to remain in Singapore, may endure abuse, neglect, and infidelity, according to news reports and organizations that provide support services.

Tuyen, who speaks halting Mandarin with Tony, says she doesn't know what her new

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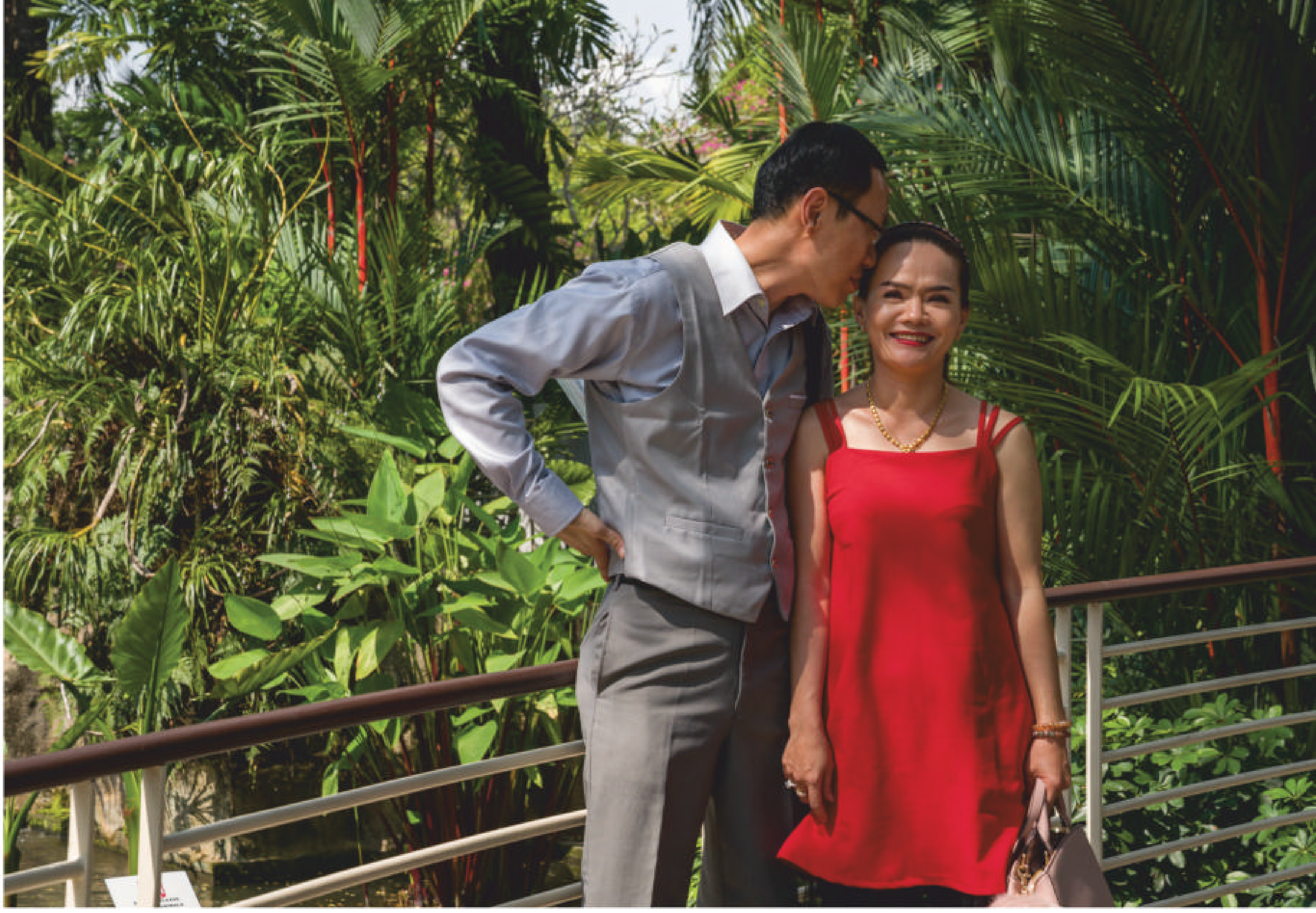


husband needs from her, so she cooks for him and keeps him company. She doesn't know if or when she'll get her long-term visit pass. That depends on the husband's monthly salary, and Tony has been out of a job. Tuyen doesn't know if her son will be able to join her in Singapore or if she'll be able to support him.

But on her wedding day, Tuyen was willing to play the role of a newlywed. "I'm very happy," she said. Then, once again, she asked the translator when she'd be allowed to work. *—AA*

Amrita Chandradas is a Singaporean documentary photographer who focuses on identity, the environment, and social issues. Follow her on Instagram *@amritachandradas*.

ABOVE

Ngoc Tuyen and Tony Kong spend time together on their wedding day in Singapore, in November 2019. A marriage broker had arranged their first meeting, in Vietnam, two months earlier.

LEFT

The Mayle Marriage Agency is one of the few left in Singapore after government crackdowns on brokers for immigration and human trafficking violations and financial scams. Many brokers moved their services online, where young women can try to catch a man's eye.

To stay and work in Singapore, marriage migrants DEPEND on their husbands to renew their visas.

04 **MYANMAR ▸ AUSTRALIA**
PHOTOGRAPHS BY **MRIDULA AMIN**

Finding Peace

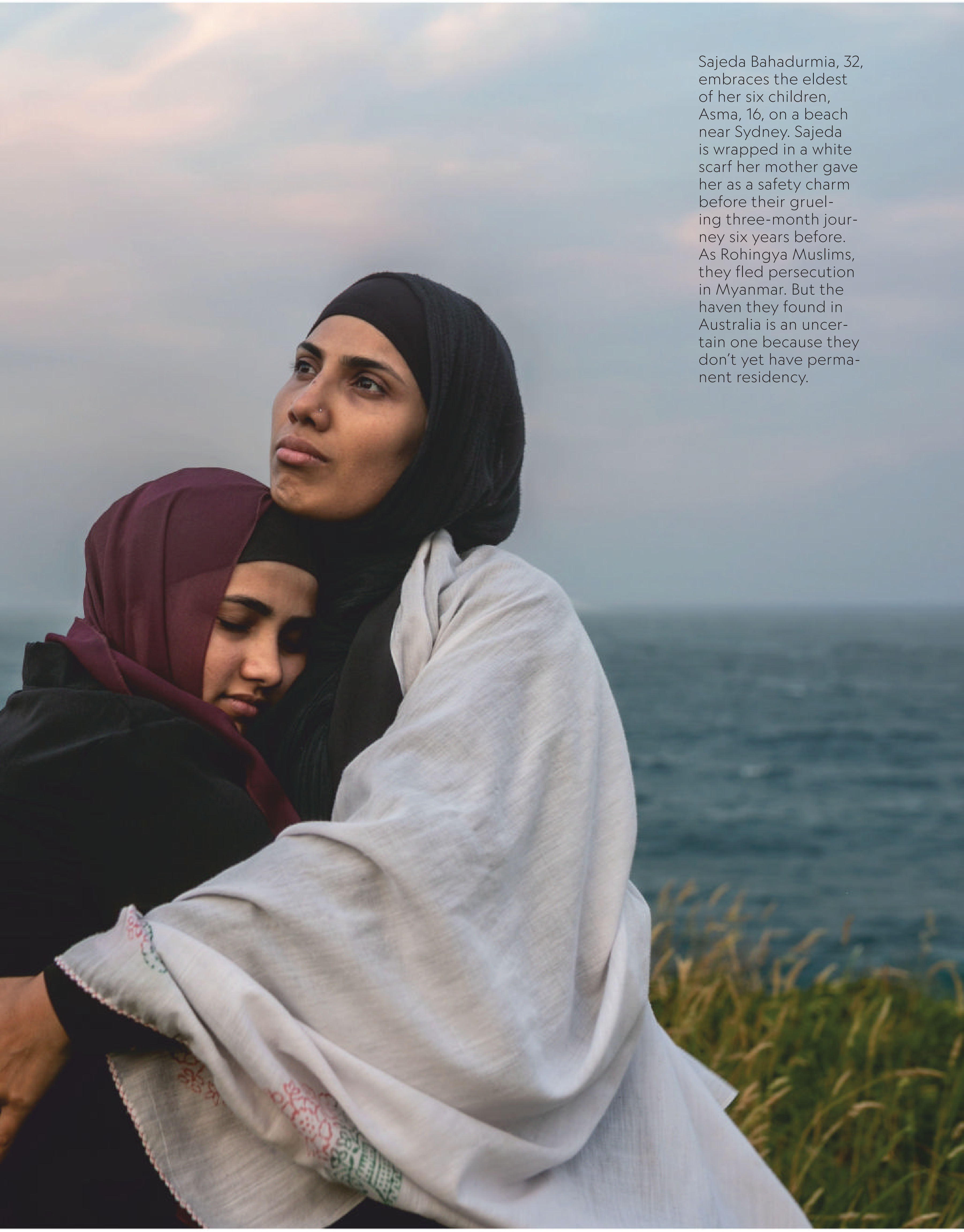
AFTER ESCAPING RELIGIOUS PERSECUTION AND ENDURING A HARROWING VOYAGE, SHE AND HER FAMILY HAVE FOUND FREEDOM AND SUPPORT IN A NEW HOME.

At first Sajeda Bahadurmia, then 26, didn't know if the men in uniform would hurt her. It was 2013, and she'd spent 14 days, from April 23 to May 6, in a boat with her husband, Nayim Ullah, and four children, sputtering across the Timor Sea from a port city in Indonesia to Darwin, on the northern tip of Australia.

The 150-foot boat was packed with more than 100 migrants—Rohingya people like them, fleeing oppression in Myanmar, as well as dozens of Bangladeshis and two Somalis. Each time a powerful wave crashed against the hull, she held her breath and kept her year-old son tied tightly to her waist as sharks circled in the dark water. Her daughter, Asma, who was 10, asked, "Are we all going to die?"

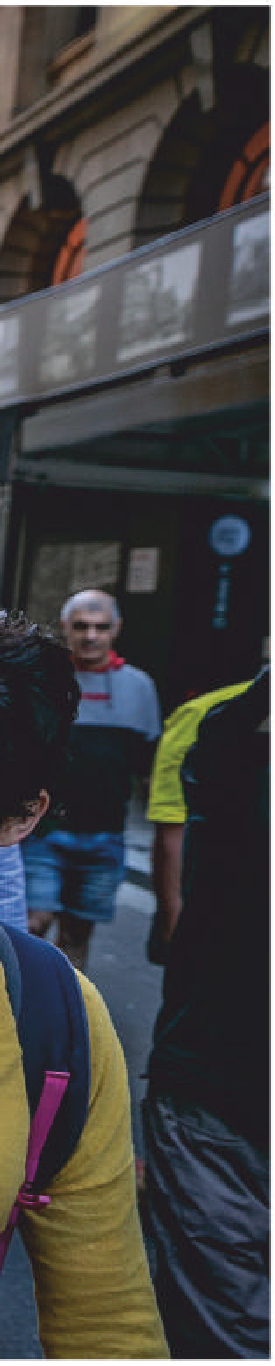
"That's ingrained in my brain," Sajeda says. "I thought: If Allah saves me, I'm never putting my children in danger again."

When the Australian Navy picked them up, she didn't know if the sailors would beat her, insult her, or grope her the way the Myanmar military had back home. But they were gentle, she says.



Sajeda Bahadurmia, 32, embraces the eldest of her six children, Asma, 16, on a beach near Sydney. Sajeda is wrapped in a white scarf her mother gave her as a safety charm before their grueling three-month journey six years before. As Rohingya Muslims, they fled persecution in Myanmar. But the haven they found in Australia is an uncertain one because they don't yet have permanent residency.

In Australia, Sajeda heard people SPEAKING their thoughts, and she felt comfortable doing the same.



ABOVE

Noor Asma, a Rohingya woman from Myanmar, holds her newborn during an English lesson in Sydney. Most of the Rohingya women in the class arrived by boat from 2013 to 2016, escaping violence.

LEFT

Sajeda, at center, protests to demand rights for refugees in Australia, where many have remained on temporary visas for years without permanent residency and others are held in detention centers. "I want our women, like other women, to have opportunities," she says. "I want everyone, like me, to fly."

They respected Muslim customs, and women carried out health checks on the refugees, who were taken to a detention center in Darwin.

The Myanmar government has long persecuted the Rohingya, a Muslim ethnic minority. Violence starting in 2012 prompted Sajeda and her family to leave, and by the end of 2017, about a million Rohingya had fled to neighboring Bangladesh and elsewhere.

"You can't trust the nights," Asma, now 16, recalls of the times when military men would burst into their homes. They violated women and dragged men into the street, arresting them or sending them into forced labor. The Myanmar government banned the word "Rohingya."

During their three months at the detention center, Asma and Sajeda were offended that the authorities addressed them by numbers according to the boat they'd arrived on: ROM006 and ROM007. Even so, they soon began stepping into their new life. When Asma started going to the public school, she didn't speak English, but she smiled and laughed across the table with her Australian classmates as they ate sausage sizzle.

"I became very obsessed with it in Darwin," Asma says.

Eventually Sajeda, now 32, and her family were resettled in Sydney under an Australian program that paid for their flights and subsidized their first months of living expenses. As refugees, they were eligible for government aid. Sajeda discovered ketchup and fell in love with Australian barbecue. She volunteered at a community kitchen, got a part-time job at her children's school, and learned to drive. The family moved into a new home in Lakemba, a Sydney suburb where Rohingya was spoken in the streets. She saw the joy in her children's eyes when they opened the door to their first house.

"The word 'freedom' just came out of nowhere," Asma says. "I'm meant to be here. That sense of belonging was overflowing in me." In Myanmar, those who spoke out could be killed. In Australia, Sajeda heard people voicing their thoughts, and she did the same. Standing outside the mosque in Lakemba, seeing Muslims spilling out into the street after prayers, she marvels at the sight: "I've never got to see that," she says. —*AA*

Mridula Amin is an Australian photojournalist based in Sydney who explores identity, migration, and social justice in the Asia-Pacific region. Follow her on Instagram *@mridulaamin*.

05 **PAKISTAN**
PHOTOGRAPHS BY **SAIYNA BASHIR**

New Choices

LEAVING THE VIOLENCE OF THEIR HOME CITY, THEY CHOSE TO PURSUE AN EDUCATION— AND FOUND A MORE OPEN CULTURE THAT INSPIRED CREATIVITY AND DISCOVERY.

The city of Quetta, Pakistan, is surrounded by soaring, snow-dusted mountains. But Farheen, 22, never ventured into them. She avoided the city's bazaars, made few friends, shunned boys. She loves to dance but only did so in front of the mirror at home; women in her culture can be shamed—or worse—for dancing. "I'm not conservative," she says. "Just terrified."

Farheen, who has only one name, is a Hazara, a member of an Afghan ethnic group and Shiite religious minority that has been persecuted, discriminated against, and massacred by rival ethnic groups, the Taliban, and other religious extremists for more than a century. Poverty and waves of war and violence in Afghanistan pushed many Hazaras out of the country.

In the 1960s Farheen's grandparents crossed into Pakistan. They settled in Quetta, now home to some half a million Hazaras. Most live in one of two walled enclaves, penned in by police checkpoints as well as perpetual fear of violence. Since 2003, hundreds, perhaps thousands, of Hazaras in Quetta have been killed in targeted

Bibi Sabar, 22, at left, takes a selfie with a friend outside Islamabad's Faisal Mosque. Bibi moved to Islamabad to study IT at the urging of her family because the violence against ethnic Hazaras like her in her hometown of Quetta made it dangerous to attend a university there.

In Islamabad, Bibi takes a bus with fellow university students to a mall. The outing would have been rare back in Quetta, where violence against Shiite Muslim Hazaras by Sunni militants makes them afraid to venture from their walled compounds.

attacks and bombings. Hazara culture can be brutally patriarchal. “They talk about honor killing in a very casual way,” Farheen says, referring to the practice of men killing women they believe have shamed the family. “It scares me.”

As Farheen puts it, “When you go to Quetta, your mind starts to close in. Your mind and heart both.” But, she might have added, when you venture away from Quetta, your mind and heart open up. Hazaras chafing against the strictures of life in Quetta may decide that to have a future, they must migrate to countries such as Australia, Iran, and Turkey. For many young Hazaras in Quetta, education has been their path to new confidence, and to freedom. In the Hazara interpretation of Islamic values, education is socially desirable and a religious imperative—a lifelong pursuit for women as well as men. For Farheen that meant leaving Quetta, in 2017, to study literature at the National University of Modern Languages in Islamabad, Pakistan’s capital.

There, more than 400 miles from home, Farheen says her fears diminished. She began taking the bus to classes and going to bustling public places. She became more open-minded. When she first heard of K-pop, the musical genre from South Korea, she dismissed it. “The boys looked like girls, and they had makeup on,” she says. But the catchy songs got her attention. She started paying attention to the lyrics, and soon she was hooked. She says she feels bad now for being judgmental. “K-pop has helped me a lot in being accepting towards new ideas.”

Farheen became curious about Korean culture. She studied the language and practiced K-pop dances. The groups sang about homophobia, mental health, and the difficulties of being a teenager, which helped her emerge from years of anxiety and depression.

She sees her foray into Islamabad as just the first step in discovering a world beyond the confines of Quetta. After graduation, she’d like to visit Canada, maybe study dance in the U.S., or tour Afghanistan, her Hazara homeland. She can imagine living in South Korea. Above all, Farheen is on a path toward freedom from her past and the weight of her culture’s history of persecution. Where she really wants to go, Farheen says, is “somewhere nobody knows me.” *—AA*

Saiyna Bashir is a Pakistani photojournalist who covers ethnic violence, health care, migration, and climate change. Follow her on Instagram *@saiynabashirphoto*.

ABOVE

Haleema, 22, at left, a Hazara from Quetta who has just one name, chats with classmates during poetry class. To support her university course work in Islamabad, Haleema teaches preschool. She plans to become a schoolteacher or university professor.

RIGHT

Another Hazara from Quetta, 22-year-old Farheen, studies English literature in Islamabad. Here, she does homework at a women’s hostel near her university. Above her bed are photos of K-pop stars whose songs she credits with opening her mind to issues such as homophobia and mental health.

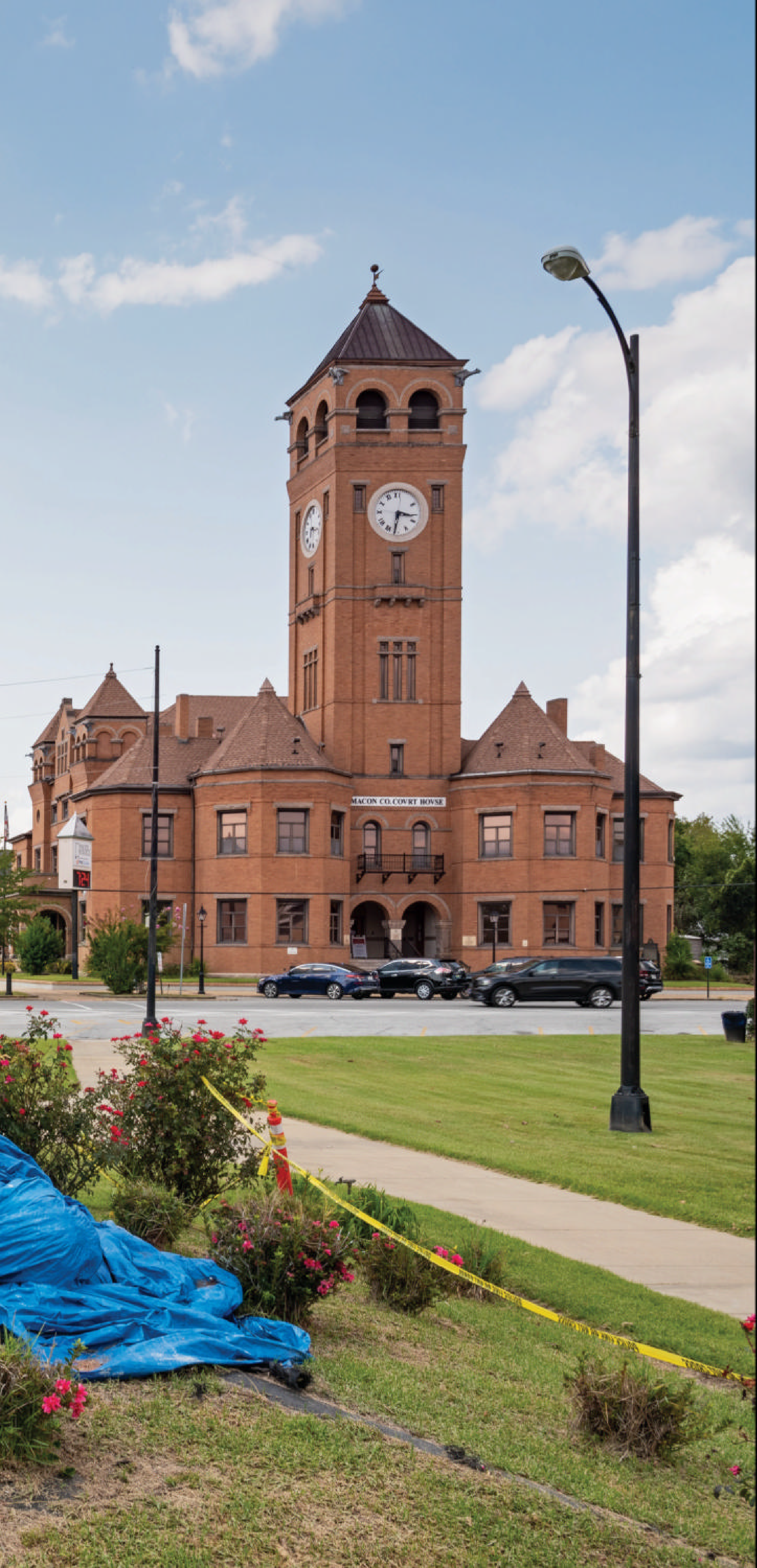
Hazaras who live under a constant fear of violence in Quetta often decide that to have a FUTURE and get an education, they must leave.

CONFEDERATE SYMBOLS ARE TARGETS AS MANY AMERICANS DEMAND THAT U.S. COMMUNITIES CONFRONT SYSTEMIC RACISM.

BY **PHILLIP MORRIS**

PHOTOGRAPHS BY **KRIS GRAVES**

RECLAIMING HISTORY



A half century after the Civil War ended, a Confederate heritage group in Tuskegee, Alabama, erected a statue honoring Rebel soldiers across from the Macon County Court House. As of last fall, the statue still stood sentry—albeit vandalized and under a tarp—as the city, now 97 percent African American, considered what to do with it.

PREVIOUS PHOTO

During protests against police brutality last year, the defaced statue of Gen. Robert E. Lee in Richmond, Virginia, became a screen for illuminated images of Marcus-David Peters and other African Americans killed by police. Peters, from Richmond, was shot while having a mental health crisis. Projection artists Dustin Klein and Alex Criqui have since added images of Black icons such as Harriet Tubman and Frederick Douglass.

EDITOR'S NOTE

Through our standard image toning processes, we de-emphasized instances of the f-word that were visible in the photo on pages 100-101. It's an extremely rare step for us to take, but it honors our policy not to use that word in stories or to display it in photographs.

Kentucky sculptor Ed Hamilton, 73, is impressively agile for a man of almost any age. On a seasonably warm fall afternoon, he easily ascends a four-foot plinth supporting a bronze statue of an enslaved man named York, who 'belonged' to the famed American explorer William Clark.

Hamilton, who is showing me around Louisville—a city eerily emptied out by coronavirus realities and sustained civil unrest tied to the police killing of Breonna Taylor—has spotted a bit of gunk covering York's right eye.

"OK, brother York, we have to keep your freedom vision clear," Hamilton says, using a red handkerchief to dab at the eye of the monument, which looks northward toward the Ohio River from a downtown park.

The city of Louisville commissioned Hamilton in 2002 to create the statue to honor York, who is believed to have been a vital part of the journey of Clark and Meriwether Lewis to explore lands west of the Mississippi River from 1804 to 1806.

Save a few journal passages written by Clark, the history of York is scant. In research for the sculpture, Hamilton says he gleaned that York essentially functioned as a free man during those two years of exploration, but was forced back into enslavement after the mission was complete.

"My vision when creating York was to show a proud and determined Black man," Hamilton says. "I wanted his eyes to be focused and strong. York had seen and tasted freedom with those eyes. He yearned for it again. His story was too important to be lost in history."

Public memorials that showcase, explain, and commemorate the stories of Black Americans since their arrival in the British colonies four centuries ago remain part of the

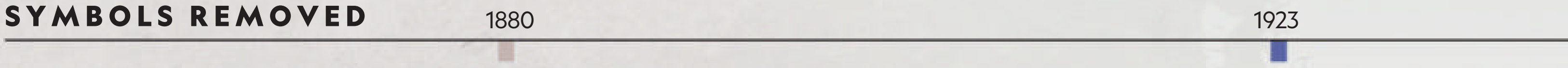
The name of Lee-Davis High School in central Virginia was removed last July, and in September the school was renamed Mechanicsville High. It had been named for Gen. Robert E. Lee and Confederate president Jefferson Davis when it opened in 1959. That was a year after Virginia school districts closed nine public schools as part of "massive resistance" to the U.S. Supreme Court's 1954 ruling in *Brown* v. *Board of Education* that rejected racial segregation in public education.

nation's missing or non-narrated stories. Until now. A historical vacuum suddenly is being reimagined and recast.

As a novel coronavirus swept the planet in 2020, the United States exploded into a period of social protest and deep reflection on the way American history is—and is not—remembered, revered, and presented. Visible Confederate symbols of the states that seceded from the Union to defend slavery were targeted for debate or removal from public display. The Southern Poverty Law Center (SPLC) has identified more than 1,940 statues, memorials, street names, and other public symbols of the Confederacy in 34 states and the District of Columbia.

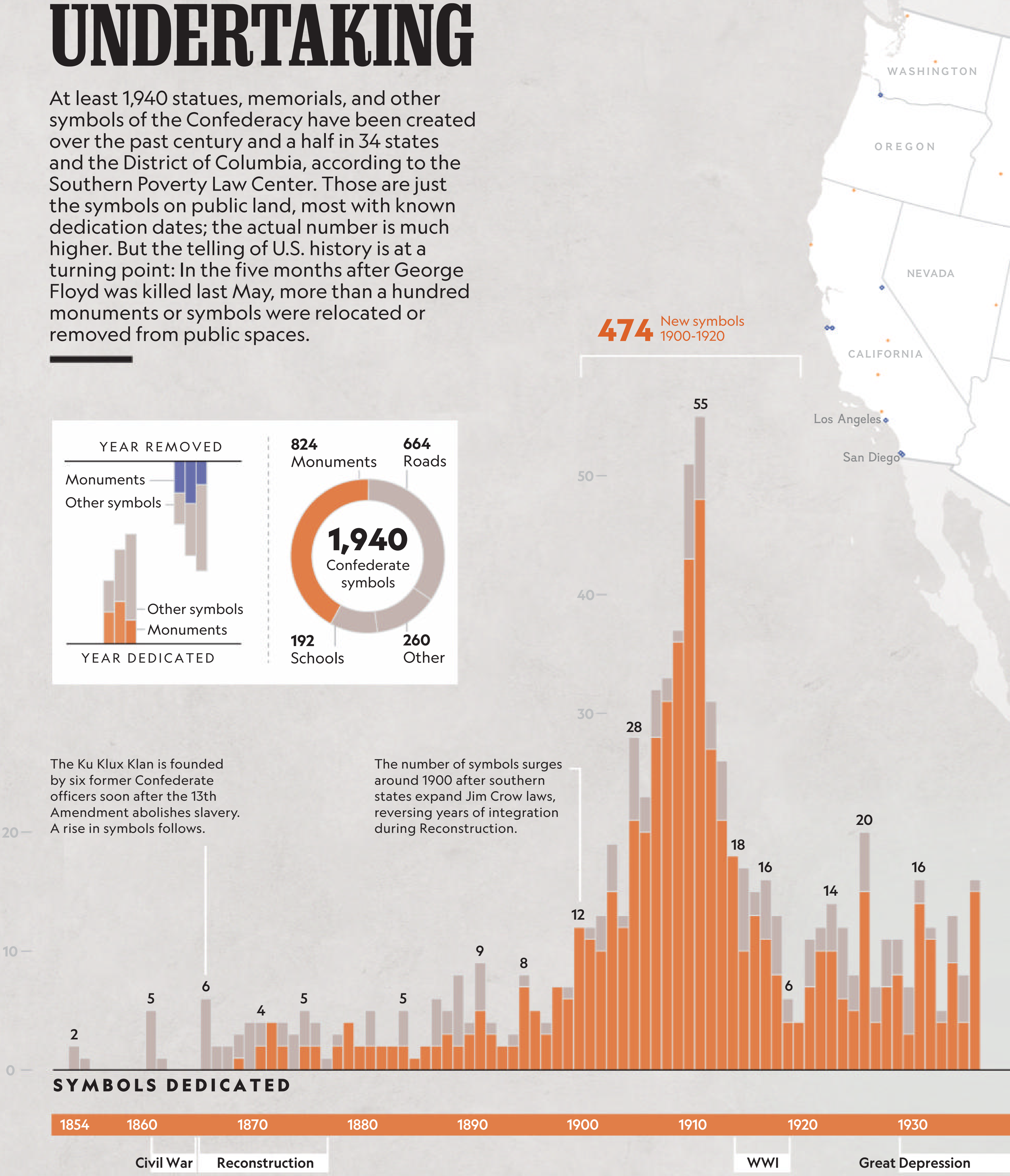
Towering statues and obelisks that pay tribute to defeated Confederates such as President Jefferson Davis and Gens. Robert E. Lee and "Stonewall" Jackson have long filled the public landscape, most notably in southern states. Lesser Confederate tributes quietly blend into the national fabric marking city boulevards, state routes, and federal highways that crisscross the nation. Scores of schools, parks, and bridges—and 10 U.S. Army bases—are named for Confederate notables, including officers who led troops in rebellion against the United States in the Civil War, which killed an estimated 620,000 people in what remains the deadliest conflict in U.S. history.

Confederate symbols continue to adorn our everyday lives because of the influence of southern civic groups that, for more than a century, have narrated the history of the war through the perspective of the Confederate states.



MONUMENTAL UNDERTAKING

At least 1,940 statues, memorials, and other symbols of the Confederacy have been created over the past century and a half in 34 states and the District of Columbia, according to the Southern Poverty Law Center. Those are just the symbols on public land, most with known dedication dates; the actual number is much higher. But the telling of U.S. history is at a turning point: In the five months after George Floyd was killed last May, more than a hundred monuments or symbols were relocated or removed from public spaces.



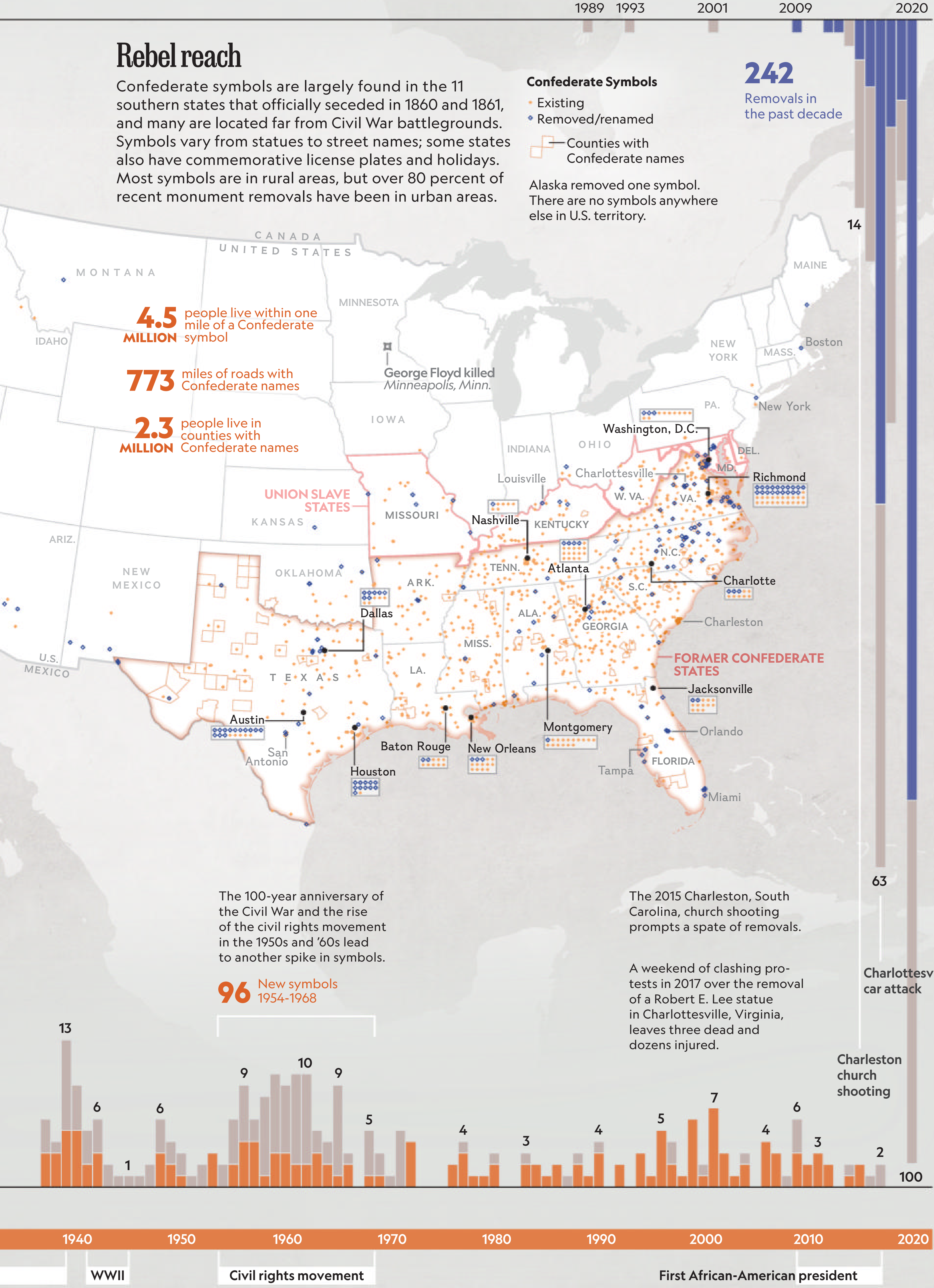
The Ku Klux Klan is founded by six former Confederate officers soon after the 13th Amendment abolishes slavery. A rise in symbols follows.

The number of symbols surges around 1900 after southern states expand Jim Crow laws, reversing years of integration during Reconstruction.

DATA AS OF NOVEMBER 12, 2020. ONLY SYMBOLS ON PUBLIC LANDS ARE COUNTED. SOME CATEGORIES HAVE BEEN MORE COMPREHENSIVELY DOCUMENTED THAN OTHERS. ONLY SYMBOLS WITH KNOWN DEDICATION DATES ARE INCLUDED IN TIME LINE.

Rebel reach

Confederate symbols are largely found in the 11 southern states that officially seceded in 1860 and 1861, and many are located far from Civil War battlegrounds. Symbols vary from statues to street names; some states also have commemorative license plates and holidays. Most symbols are in rural areas, but over 80 percent of recent monument removals have been in urban areas.



Confederate Symbols

- Existing
- Removed/renamed
- Counties with Confederate names

Alaska removed one symbol. There are no symbols anywhere else in U.S. territory.

242 Removals in the past decade

4.5 MILLION people live within one mile of a Confederate symbol

773 miles of roads with Confederate names

2.3 MILLION people live in counties with Confederate names

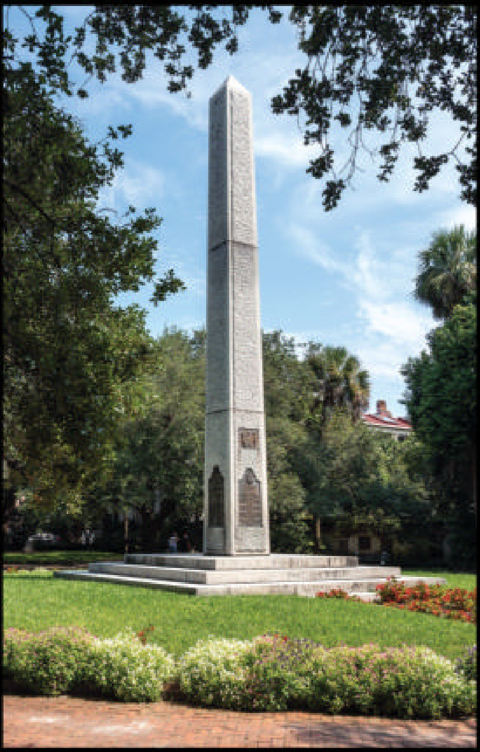
The 100-year anniversary of the Civil War and the rise of the civil rights movement in the 1950s and '60s lead to another spike in symbols.

96 New symbols 1954-1968

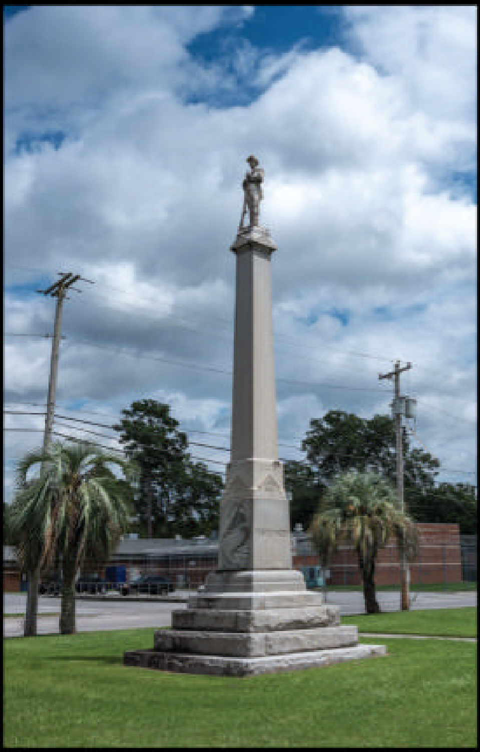
The 2015 Charleston, South Carolina, church shooting prompts a spate of removals.

A weekend of clashing protests in 2017 over the removal of a Robert E. Lee statue in Charlottesville, Virginia, leaves three dead and dozens injured.

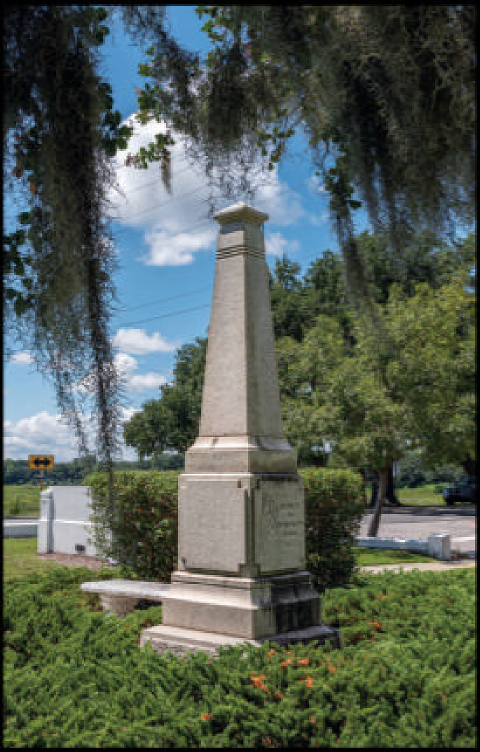
MONICA SERRANO, SOREN WALLJASPER, AND TED SICKLEY, NGM STAFF. LAWSON PARKER.
SOURCES: SOUTHERN POVERTY LAW CENTER; U.S. CENSUS BUREAU



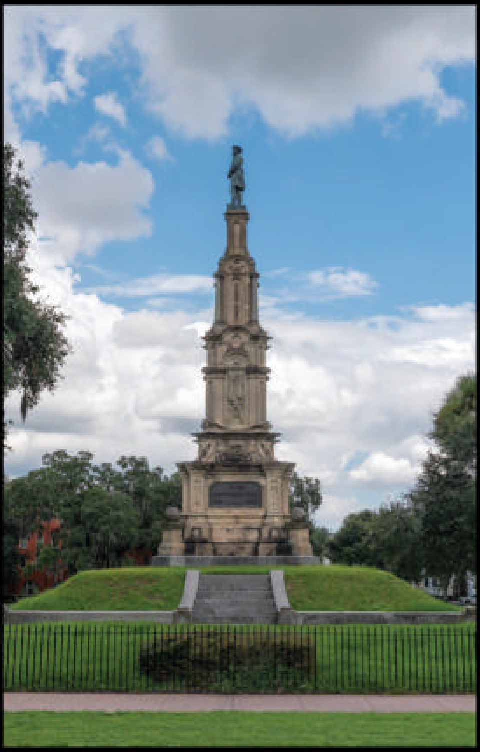
Charleston, South Carolina



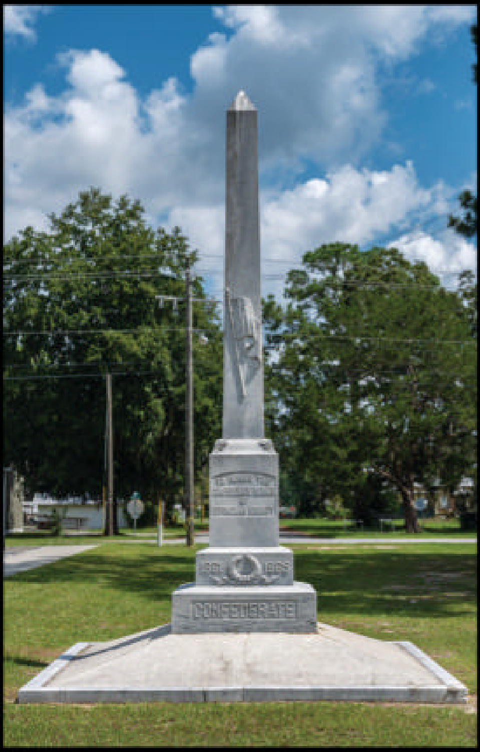
Bamberg, South Carolina



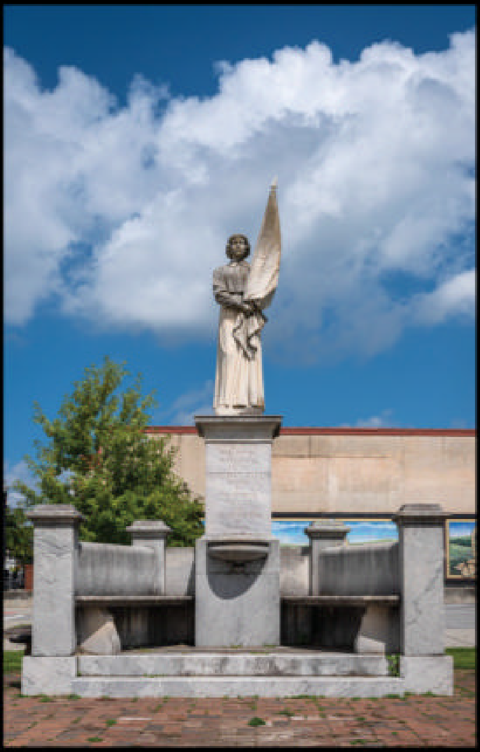
Beaufort, South Carolina



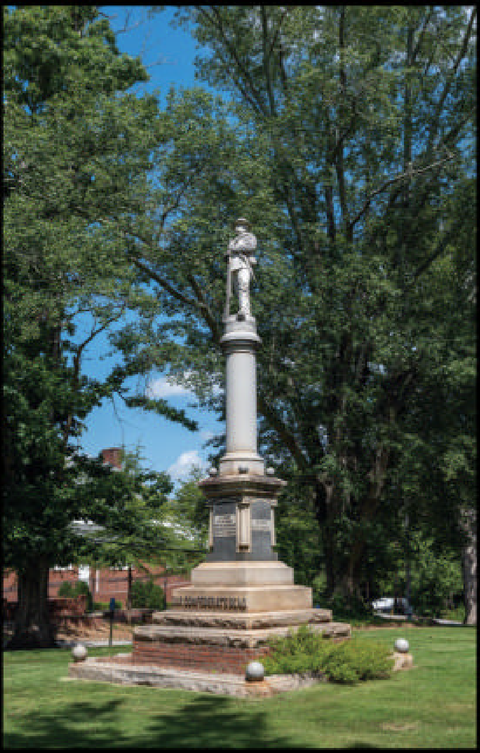
Savannah, Georgia



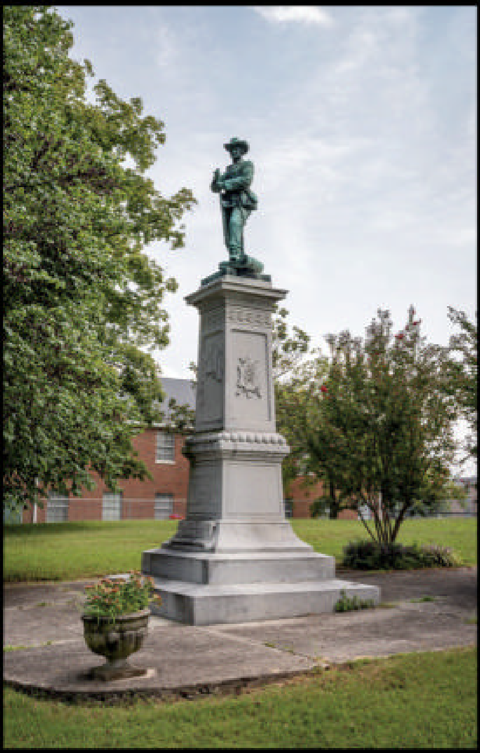
Springfield, Georgia



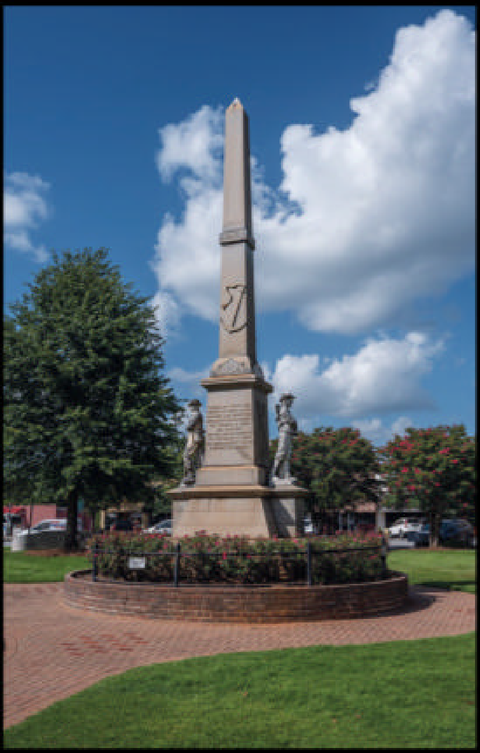
Thomson, Georgia



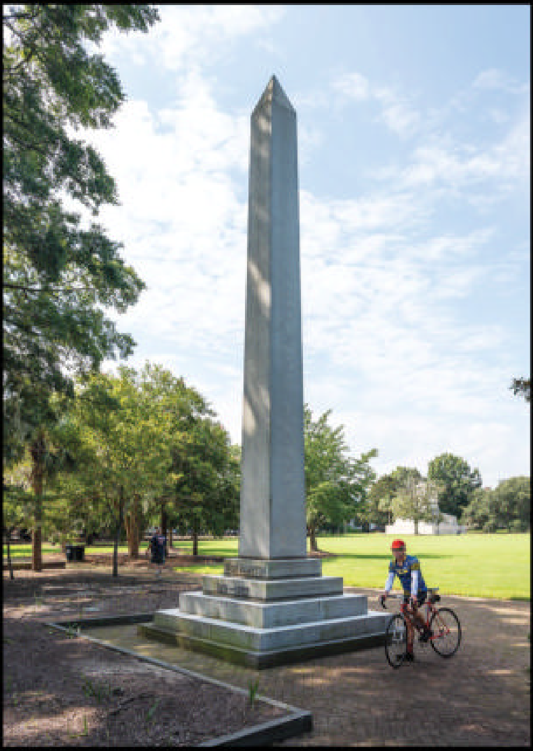
Greensboro, Georgia



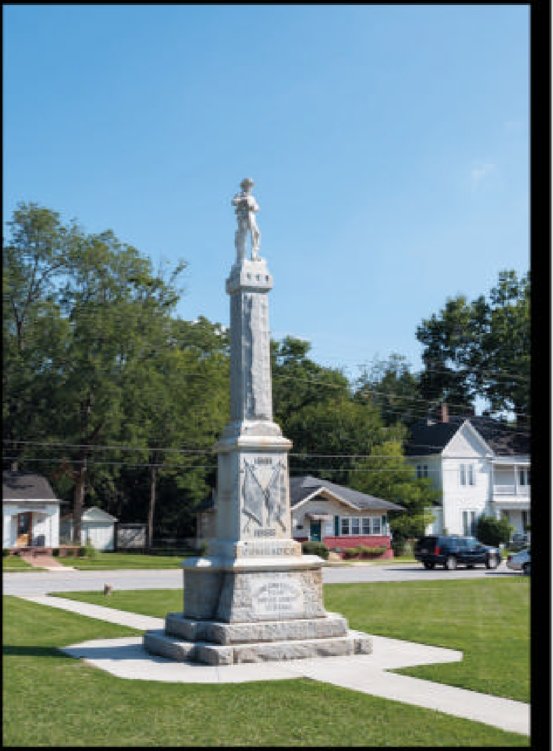
Gallatin, Tennessee



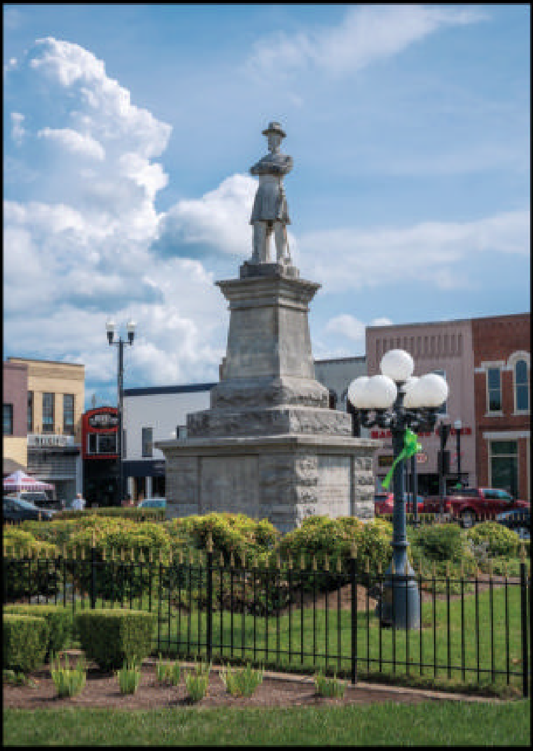
Monticello, Georgia



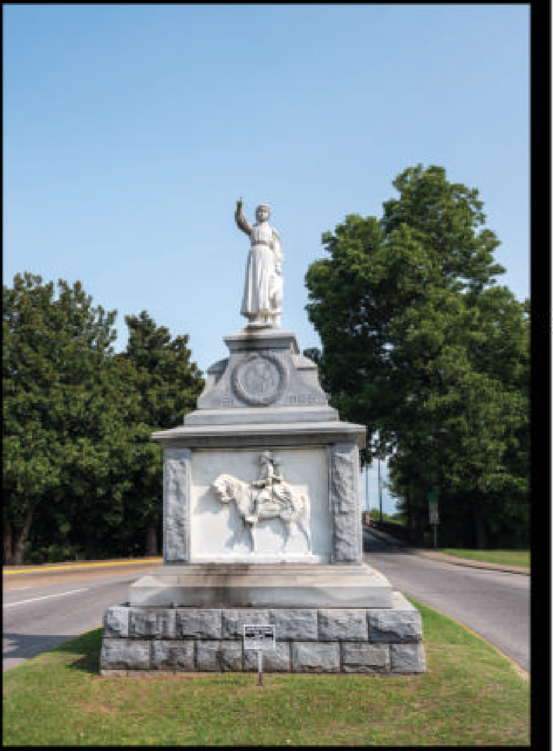
Charleston, South Carolina



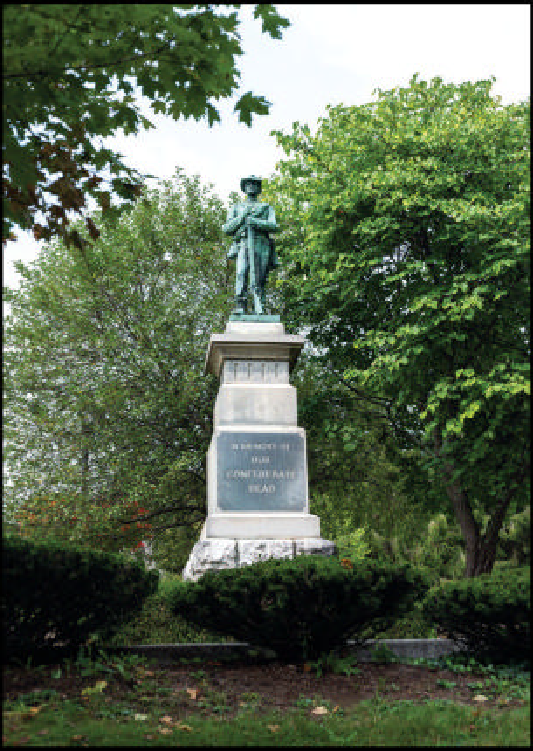
Opelika, Alabama



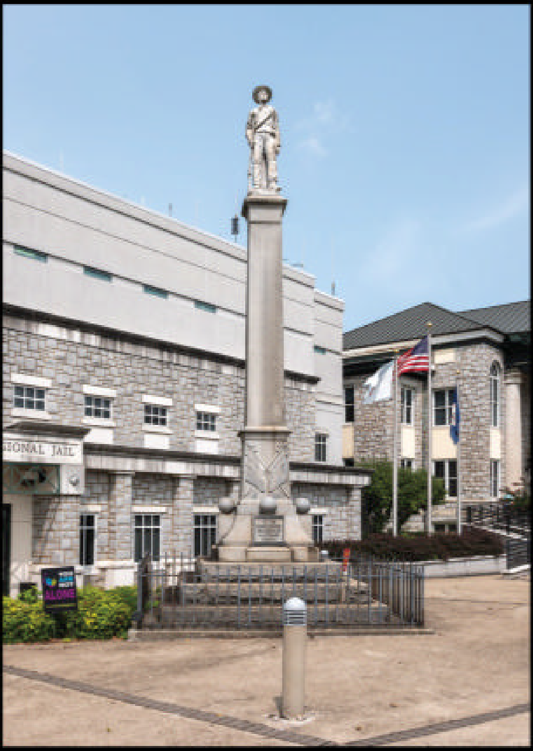
Lebanon, Tennessee



Gadsden, Alabama



Lewisburg, West Virginia



Covington, Virginia

Hundreds of memorial statues and obelisk monuments dedicated to Confederates stand in numerous states, especially those that seceded from the Union to ignite the Civil War. Many of the monuments are the result of the efforts of the United Daughters of the Confederacy (UDC), a group of descendants of men who served in the Confederate military. Since its founding in 1894, the group has cast Confederates as warriors for a lost cause—a narrative that frames the war as a battle over states' rights and de-emphasizes the horrors of slavery. The placement of such monuments near courthouses and other government buildings has signaled to Black Americans that although slavery is no more, their place as equals in society isn't assured.

Defenders of Confederate monuments in Charleston, South Carolina, fly a Confederate flag during a Black Lives Matter protest in the city last August. The flag is still seen throughout the country.

CONFEDERATE iconography has long been a painful and enduring reminder to Black Americans of the enslavement of their ancestors and the creation of brutal Jim Crow laws designed to reduce the citizenship rights of freed Black Americans. The symbolism and messaging—especially around local courthouses and state capitols—didn't happen by accident.

After northern troops were pulled from the South in the 1870s, effectively ending post-Civil War Reconstruction, an ambitious and well-financed effort was mounted to advance the story of the Confederate soldier as a hero and valiant defender of a noble lost cause. In this narrative, the Confederates were defending southern states' rights to set their own policies and rejecting overreach from the North. Many southern war survivors and their descendants were quick to embrace this version of the Confederate story.

This historical crusade depicted the antebellum South in a mostly benevolent light and played down the horror and inhumanity of enslavement—even though southern states' desire to allow slavery was at the core of the "states' rights" argument. Through the strategic placement of statues and monuments, combined with powerful sway over public school curriculum (as recently as 2015, some textbooks in Texas soft-pedaled slavery by describing enslaved people merely as "workers"), Confederate propaganda often prevailed—especially in the American South.

But when George Floyd, an African American, was killed last May by a white Minneapolis, Minnesota, police officer during a gruesome street arrest recorded on cell phone videos, the U.S. plunged into a period of deep introspection. A reconsideration of the nation's racially fraught history was launched, first with mass demonstrations and then with calls for the removal of public symbols of white supremacy throughout the American landscape. In some cases, protesters took monument removal into their own hands.

A racially diverse movement of millions demanded racial justice in the wake of Floyd's death and other police killings of unarmed African Americans. Widespread calls for a major reconsideration of how the nation's history of colonization, racism, and white supremacy is presented through art and monuments have led to unprecedented action.

One clear illustration of the rapid change and national reckoning under way was a $250 million pledge by the Andrew W. Mellon Foundation in October to transform the way American history is represented in public spaces. The initiative is designed to fund new monuments, contextualize iconography, and in some cases, relocate memorials.

The Mellon Foundation has long steeped its philanthropy in advancing social justice. Its pledge was conceived before Floyd's death, but the sheer scope of the investment is certain to draw attention to existing public art and emerging works that the foundation says it is committed to identifying and funding—art that better reflects a more complete history of the nation.

"There is unexplored history and opportunities for learning all around us," says Elizabeth Alexander, the foundation's president and a noted academic, poet, and essayist. "This effort will look closely at equity and inclusion of art in the public space. Not only will we look at who has been resourced historically, but those organizations and themes that have been... under-resourced.

"We are committed to identifying stories and voices that haven't been heard. Voices that tell us where we've been, who we are, and who we can aspire to be," says Alexander.

THEN there is the flag.

The battle flag of the Confederacy continues to be displayed in the United States, particularly in the 11 southern states that ignited the Civil War by formally seceding from the Union in 1860 and 1861: South Carolina, Mississippi, Florida, Alabama, Georgia, Louisiana, Texas, Virginia, Arkansas, North Carolina, and Tennessee. Missouri and Kentucky were divided over secession and slavery and never formally seceded. People from those states fought on both sides of the Civil War. Confederate officials considered those states part of the rebellion, which is why the Confederate flag—with its blue "X" on a red background—includes 13 stars.

Today this flag has come to symbolize not just the lost cause of the 19th century, but also a part of southern culture that continues to resist the influence of the North—and implicitly celebrates slavery and the notion of white supremacy.

The flag's symbolism has endured partly

ICONS OF A DIVIDED PAST

More than 200 Confederate figures are memorialized in public spaces throughout the United States. These three men have the most monuments, markers, highways, schools, and other symbols named for them today.

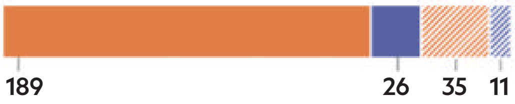
● Confederate States

● Union States and Territories ▨ Removed

Robert E. Lee

215 | **46**

In place | **Removed**

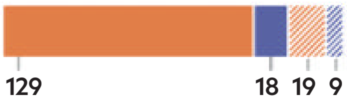


Lee originally was offered command of the Union Army in 1861. Instead, he joined his home state of Virginia's forces and went on to lead the Confederate Army. After surrendering in 1865, he became president of Virginia's Washington College (now Washington and Lee University).

Jefferson Davis

147 | **28**

In place | **Removed**

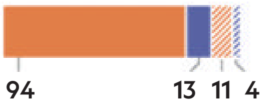


The U.S. representative and senator from Mississippi became the first and only president of the Confederate States of America. He was captured by Union forces in 1865, imprisoned for two years, and charged with treason, but the case was dropped.

Thomas Jonathan "Stonewall" Jackson

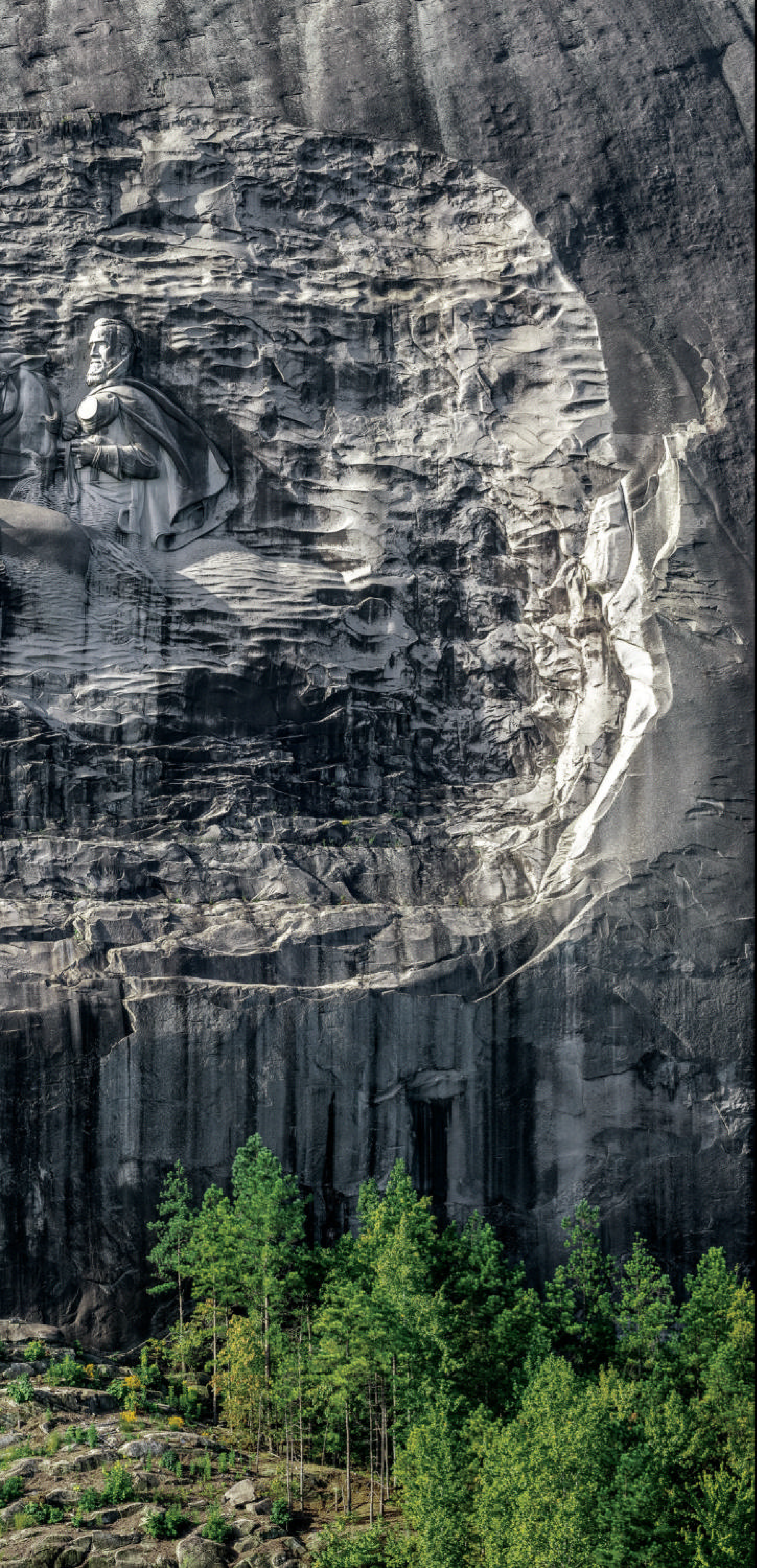
107 | **15**

In place | **Removed**



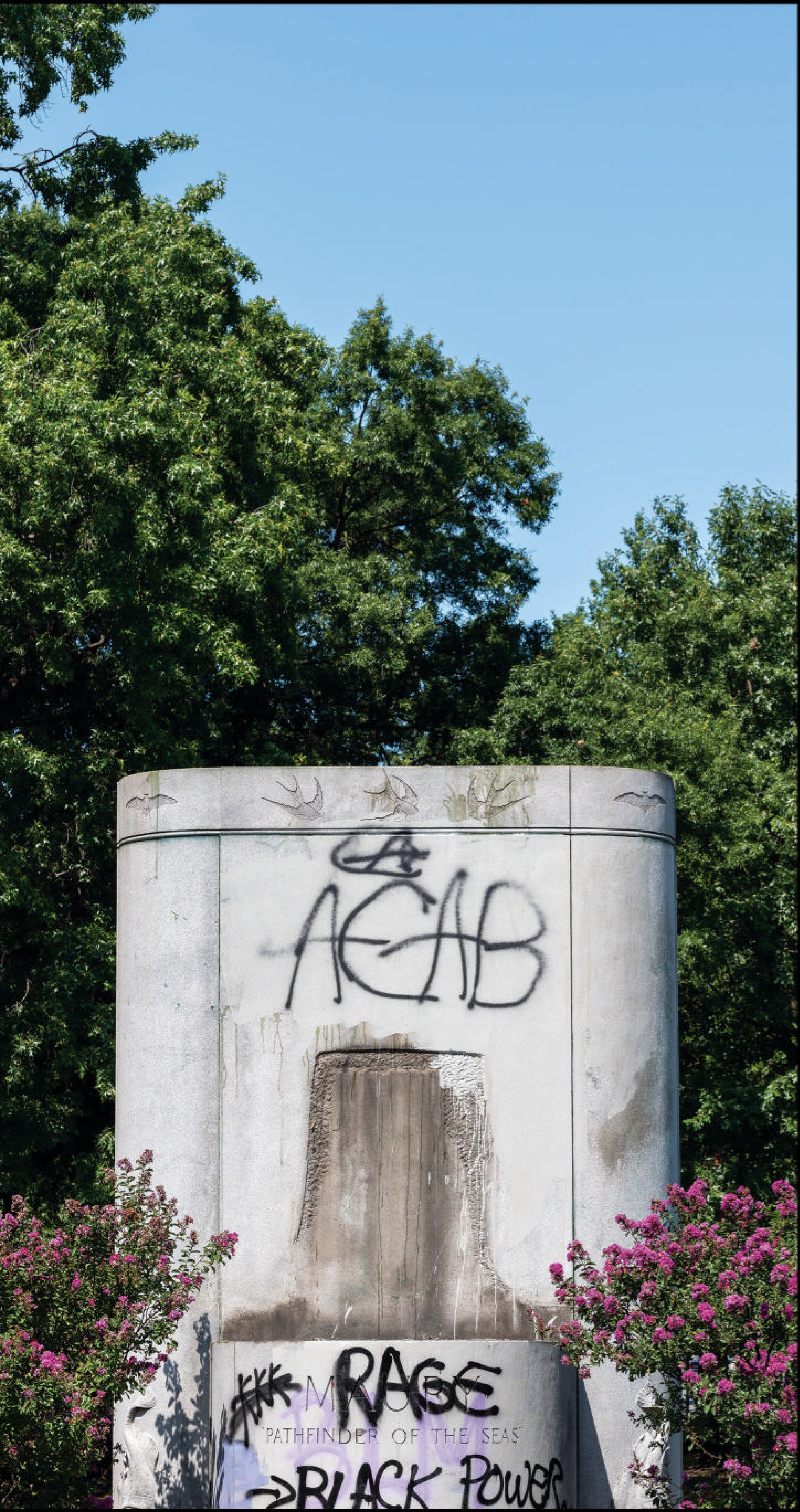
When Virginia seceded from the Union in April 1861, Jackson organized a group of amateur soldiers into an army brigade. He would become one of the Civil War's most famous commanders, but died in 1863, days after his troops accidentally fired on him.

DATA AS OF NOVEMBER 12, 2020. REMOVED SYMBOLS INCLUDE THOSE THAT WERE RELOCATED AND RENAMED. MONICA SERRANO, NGM STAFF. RESEARCH: LAWSON PARKER. SOURCE: SOUTHERN POVERTY LAW CENTER. PHOTOS (FROM TOP): GETTY IMAGES; NETTERVILLE BRIGGS, GETTY IMAGES; BETTMANN/GETTY IMAGES



Depictions of Davis, Lee, and Jackson are carved into Stone Mountain, Georgia. The mountain was a gathering site for the Ku Klux Klan when the UDC conceived the idea of a monument there in 1912. It finally was completed in 1972 by the state of Georgia. Now the centerpiece of a popular state-owned park, the carving draws protesters' ire that the state government sponsors a monument to white supremacy.

MAURY
"PATHFINDER OF THE SEAS"
BLM



The statue of Confederate naval officer Matthew Fontaine Maury on Richmond's Monument Avenue, dedicated in 1929, was one of many monuments the city took down last summer. Its removal by crane spared it from being toppled during June protests in the aftermath of George Floyd's death. The statue showed Maury, who resigned his commission as a U.S. Navy commander to join the Confederacy, seated and holding a marine chart, under a globe ringed with sailors and farmers in a storm. Now, just the plinth remains.

because of its mobility: It is displayed on T-shirts, hats, and bumper stickers. Long a mainstay of NASCAR, the flag has proved stubbornly resistant to efforts by the sport's organizers to ban it from its venues. State and local governments also have embraced the flag, although the recent racial justice movement, sparked after nine African Americans were killed in a 2015 shooting at a South Carolina church before fully erupting with Floyd's slaying, has fueled some change on that front.

Until last June, Mississippi's state flag contained the Confederate emblem. The flag was flown from the State Capitol in Jackson, city halls, and the lawns and chambers of its state and local courthouses.

Retired Mississippi Supreme Court justice Reuben Anderson, 78, is well acquainted with various forms of Confederate iconography, especially the flag of his native state. The great-grandson of slaves, Anderson was the first African American to graduate from the University of Mississippi's law school, in 1967.

While Anderson studied at Ole Miss, a Confederate flag was considered an essential dormitory accessory for most students, he recalls. The university's mascot was a costumed Rebel fighter, and the school's marching band performed in Confederate-themed uniforms.

Less than two decades after graduating, Anderson became the first Black jurist to sit on the Mississippi Supreme Court, in 1985. The state's flag remained a constant presence in his life.

"Every courtroom I ever walked into as a lawyer, I would take a look at the state flag and reflexively bristle," Anderson says. "I was a judge for 15 years, and whenever I entered a courtroom, everyone stood. But I always knew the Confederate flag was present in the room, and it sent a clear signal to me: I was not wanted in that room—at least not in my capacity."

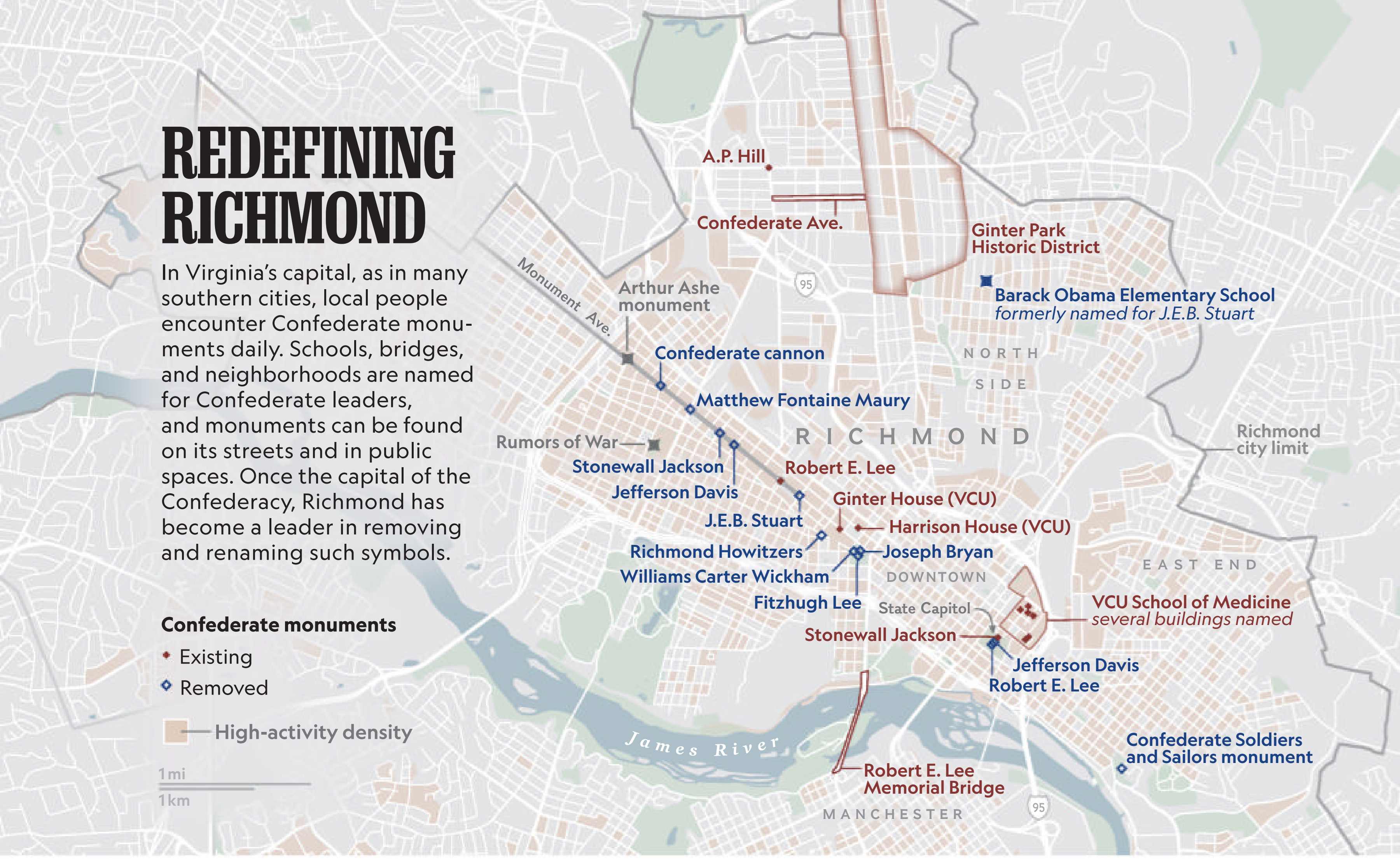
Mississippi's state flag was retired in June, ushered into museums and history books. The move was overwhelmingly sanctioned by the state legislature and by a measure signed into law by Governor Tate Reeves. Through the summer of 2020, much of the rest of the nation also continued to examine how its history is presented or celebrated, especially in public spaces.

Floyd's death and the police killing of Breonna Taylor in March in her own apartment in Louisville, Kentucky, fueled a groundswell of opposition to symbols of white supremacy and intolerance. Few cultural institutions were left unscrutinized. With new urgency, state and local governments, universities, and corporations took steps to distance their names and brands from images of America's antebellum and white supremacist past.

Quaker Oats and Mars Food pledged to remove popular but polarizing stereotypes from Aunt Jemima syrup and pancake mixes, and Uncle Ben's rice. Clemson University stripped the name of former U.S. vice president John C. Calhoun, a slavery proponent, from its honors college. The University of Southern California removed the name of Rufus von KleinSmid, a noted eugenicist, from a prominent building on campus. Princeton University removed the name of Woodrow Wilson, America's 28th president, from its school of public policy because of what a university statement called his "racist thinking." The university announced in October that it plans to build a new residential college on a site that for more than 50 years held a building named after Wilson. The new college will be named for Mellody Hobson, a Black alumna, who is president and co-chief executive of Ariel Investments.

THE questions about our history endure: What symbols from our past should be reconsidered or discarded? What stories demand a more complete and honest retelling? How should history be taught or more fully contextualized? And finally, who owns history?

Richmond, Virginia, once the capital of the Confederate States, has been a focus of protesters' push for a reckoning of how America's history of slavery and white entitlement is presented. Richmond's famous Monument Avenue has showcased majestic statues of Confederate leaders Lee, Davis, and others—many of which were toppled or defaced by protesters or rushed into storage by government officials. In October retired business executive Tim White, 83, visited Monument Avenue on a busy Saturday with his family. "I can appreciate what's happening out here today—people have a right to protest and express their opinions," White told me. "Robert E. Lee was not perfect. He was a creature of his time. America has made amazing progress since his death. But I don't believe we continue that progress by destroying the nation's history or pretending that it never occurred."



REDEFINING RICHMOND

In Virginia's capital, as in many southern cities, local people encounter Confederate monuments daily. Schools, bridges, and neighborhoods are named for Confederate leaders, and monuments can be found on its streets and in public spaces. Once the capital of the Confederacy, Richmond has become a leader in removing and renaming such symbols.

DATA AS OF NOVEMBER 12, 2020. SOREN WALLJASPER AND TED SICKLEY, NGM STAFF.
SOURCES: SOUTHERN POVERTY LAW CENTER; U.S. CENSUS BUREAU; OPENSTREETMAP

Several hours later, after the plaza had cleared of all but a few people, Dustin Klein, a lighting designer, and Alex Criqui, an artist and writer, set up shop directly across the street from the Lee statue. Using a high-definition projector and a laptop computer, they spent just under two hours projecting images onto the statue, as they had almost nightly for nearly three months after Floyd's death.

"The Lee monument was specifically created as a symbol of white supremacy," Criqui said. "By putting a Black man's image on the statue, we created something that no one in Richmond could have visualized before we did it."

Now, not only is the history of the Confederacy being judged, but other icons of American history are being reconsidered. Monuments celebrating former presidents George Washington, Ulysses S. Grant, Theodore Roosevelt, and Abraham Lincoln have become high-profile targets for attack, removal, or intense review as the histories of the men they celebrate have been scrutinized. The sweep of reconciliation also grew globally to include unflinching looks at British colonial-era politicians such as Winston Churchill and Cecil Rhodes. Italian explorer Christopher Columbus in particular had a harsh year in review.

Using contemporary values to judge the moral failings and atrocities of ancestors, and to reevaluate the lives and legacies of canonized leaders, is a morally challenging exercise that questions historical narratives that have been woven into our society. Even so, a growing number of institutions, nations, and historians seem ready to embrace a deconstruction of the past to better understand and improve the present and future.

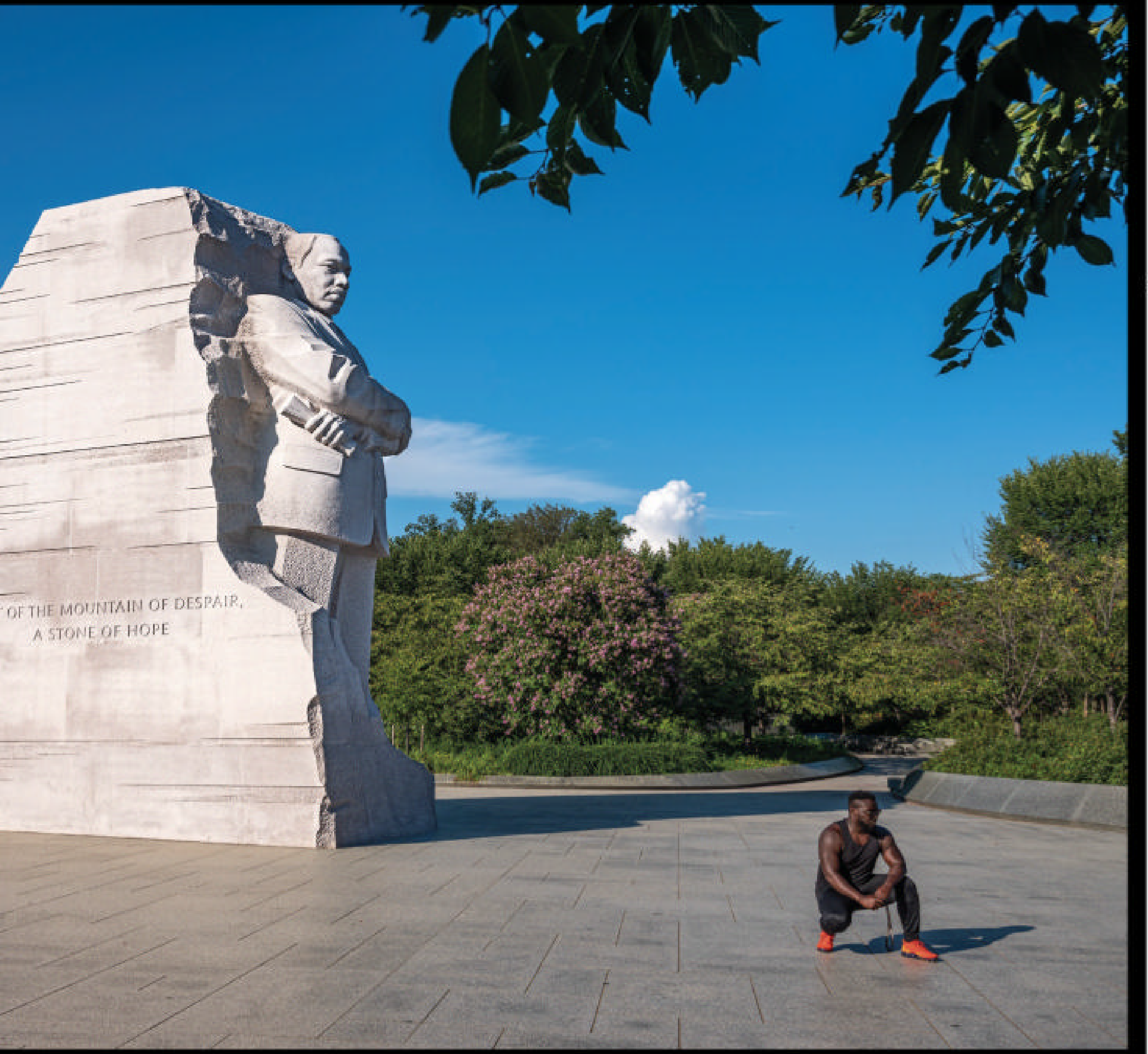
"Nothing about the current moment is happening in a vacuum or out of context," says Hilary Green, associate professor of history in the Department of Gender and Race Studies at the University of Alabama. "The death of George Floyd was the trigger that led to the current intense introspection and demands for change that we now hear, but the momentum that got us to this point has been steadily building for five years."

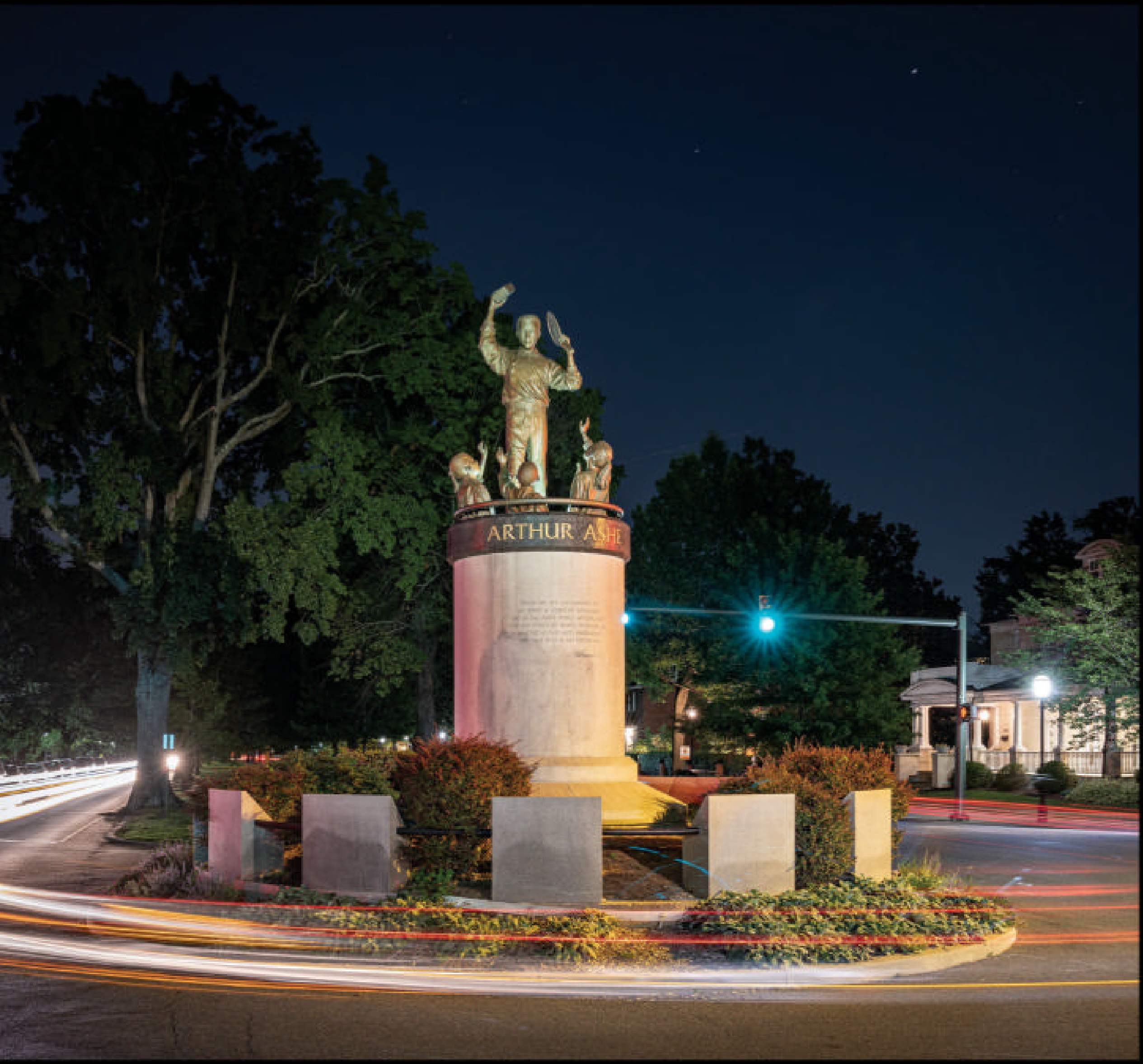
NINE Black parishioners were killed in a Charleston, South Carolina, church in 2015 by a white supremacist intent on inciting a race war. America was stunned and grieved, but did not rise in mass protest.

In 2017 a peaceful white protester was fatally mowed down by a car driven by a white supremacist after a Unite the Right rally of mostly neo-Nazis and white supremacists gathered in Charlottesville, Virginia, to protest the planned

RUMORS OF WAR

WOMEN'S RIGHTS PIONEERS





Many recent monuments attempt to correct the imbalance in public honors by showcasing the contributions of African Americans, Native Americans, and women. Clockwise from top left:

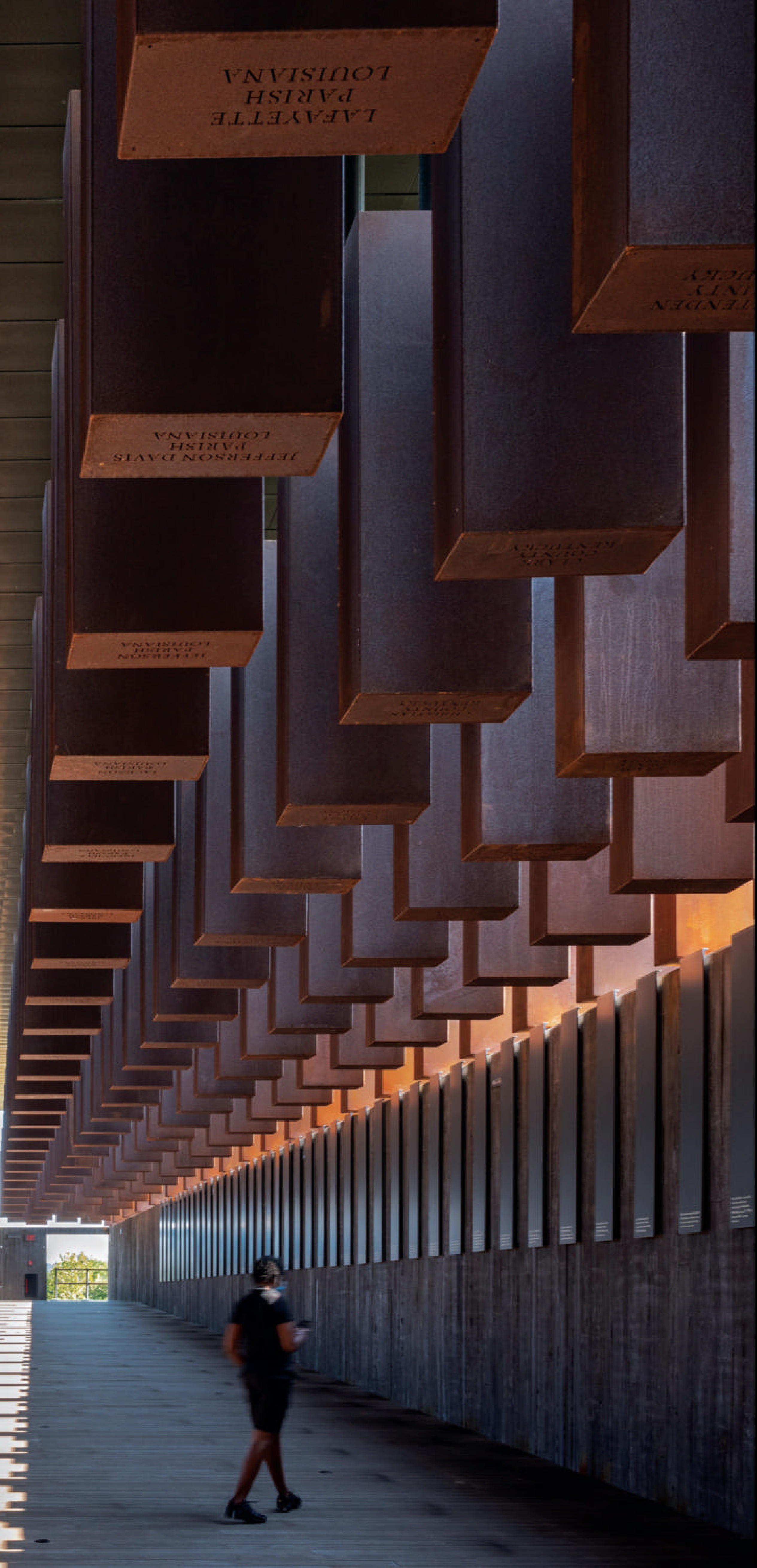
"Rumors of War," 2019. Virginia Museum of Fine Arts, Richmond, Virginia Artist Kehinde Wiley modeled his equestrian statue of a young African-American man in street clothes on the nearby statue of Confederate general J.E.B. Stuart in a heroic pose.

Martin Luther King Jr. Memorial, 2011. West Potomac Park, Washington, D.C. The assassinated civil rights icon is the first African American to be honored with his own memorial in the monumental heart of the U.S. capital, midway between those for Presidents Thomas Jefferson and Abraham Lincoln.

Arthur Ashe Monument, 1996. Monument Avenue, Richmond, Virginia First renowned as a tennis player, Black Richmond native Arthur Ashe used his sports fame as a platform for civil rights activism. His hometown placed his statue along the same road as the statues of Confederate leaders.

Women's Rights Pioneers Monument, 2020. Central Park, New York City, New York To commemorate a hundred years of women's suffrage in the United States, a statue of suffragists Sojourner Truth, Susan B. Anthony, and Elizabeth Cady Stanton was dedicated last August. It is the first statue of nonfictional women in the park.

PERSON COUNTY NORTH CAROLINA
MARSHALL COUNTY MISSISSIPPI
PENDER COUNTY NORTH CAROLINA
MARION COUNTY MISSISSIPPI
CORYELL COUNTY TEXAS
MARION COUNTY MISSISSIPPI



Visitors to the National Memorial for Peace and Justice in Montgomery, Alabama, walk beneath dangling steel monuments. Each represents one of the 800 U.S. counties where racial lynching occurred and is inscribed with the names of victims in that county. The memorial was founded by the Equal Justice Initiative, which works toward criminal justice reform and education on racial justice. Memorial staff also works with communities where lynching occurred to erect markers, collect soil, and illuminate this chapter of history.

removal of a Lee statue from that city. Still, America didn't rise in sustained protest.

There was clearly something about watching Floyd die under the knee of a police officer that caused so many to react so strongly. Perhaps it was that Floyd died at the hands of publicly funded officers tasked with protecting citizens—and that many African Americans have long felt singled out for poor treatment by police. Maybe it was restless reflection and disillusionment caused by a pandemic that's been particularly deadly to minorities and low-income people.

Since the Charleston massacre, the SPLC has been keeping track of the nation's Confederate monuments and names attached to schools, roads, parks, or other spaces. One of the group's goals has been to illuminate often seemingly benign or ignored symbolism, provide context for iconography represented, and change or remove vestiges of racism from the public arena. In the five months after Floyd's death, more than 100 monuments or symbols had been relocated or removed from public spaces, an effort unlike any other in recent years, according to the SPLC.

"THE past is never dead. It's not even past," wrote William Faulkner, one of the most famous literary sons of the South. That expression is key to understanding how southern history often has been distorted, if not weaponized, to control the public narrative about the Confederacy.

How did hundreds of monuments and symbols end up being built or strategically placed throughout southern states? Better yet, how did Confederate iconography end up in states such as Ohio, Pennsylvania, and New York that fought on the Union side? And why were such symbols erected in states such as Alaska and Montana, which weren't formed until after the Civil War?

One of the best answers to those questions leads back to Richmond, where an association known as the United Daughters of the Confederacy (UDC) is headquartered less than a mile from the statue of Lee.

Formed in Nashville, Tennessee, in 1894 and based in Richmond since 1957, the group became leaders of the lost-cause interpretation of the Civil War that dismisses slavery as a central tenet of the conflict. A group of white, mostly middle- and upper-class women, who in the late 1800s could not yet vote, became prodigious, influential fundraisers, committed to building monuments honoring dead Confederate soldiers throughout the South and beyond.

Why were they so determined to shape the narrative of Confederate heroes and preserve the memories of soldiers who seceded from the Union and died defending slavery? University of North Carolina at Charlotte professor Karen Cox has wrestled with that question for 30 years.

"The United Daughters of the Confederacy weren't concerned with the past—they were far more ambitious than that," says Cox, author of the upcoming *No Common Ground: Confederate Monuments and the Ongoing Fight for Racial Justice*. "The UDC was concerned about the future. They were committed to vindicating their ancestors and carefully curating the legacies they wanted presented to future generations. Even before suffrage, these women were plugged into politicians and understood the issues of the day, especially in regard to Reconstruction." The influence of the UDC's building campaigns can still be seen across the U.S. Scores of statues, memorials, and parks honoring Confederate soldiers remain in public spaces.

Perhaps the grandest example of the UDC's vision is the Confederate Memorial Carving in Stone Mountain, Georgia, featuring Lee, Jackson, and Davis. The UDC first envisioned the mountainside carving in 1912, a massive undertaking sometimes referred to as the Mount Rushmore of the Confederacy. The monument wasn't completed until 1972.

Today UDC headquarters functions mostly as a library and a meeting place for its members. It's an intensely private organization, and its leaders can be difficult to reach, especially since the Charlottesville protest. My phone calls and emails to the UDC weren't returned. But it remains committed to honoring the Confederacy. A rare statement, posted on its website in 2018, reads in part: "We are saddened that some people find anything connected with the Confederacy to be offensive. Our Confederate ancestors were and are American. We as an Organization do not sit in judgment of them nor do we impose the standards of the 19th century on Americans of the 21st century."

The statement concludes, "Join us in denouncing hate groups and affirming that Confederate memorial statues and monuments are part of our shared American history and should remain in place."

Many African Americans have long chafed at the celebration of Confederate symbols. But it wasn't until Floyd's death that enormous, racially diverse swaths of American society began to urgently reconsider how race and racial issues are understood and publicly addressed both symbolically and politically. Perhaps nowhere is this better seen than in former judge Reuben Anderson's home state of Mississippi.

The second state to secede from the Union, in January 1861, Mississippi incorporated the Confederate battle flag as part of its state flag nearly 30 years after the Civil War ended and appeared to have no intention of abandoning it. The state legislature routinely avoided voting on bills to remove it.

Less than two months before Floyd became a household word, Reeves, Mississippi's governor, declared April as Confederate Heritage Month in the state. Mississippi has the largest Black population of any U.S. state per capita, but there was nothing unusual about the resolution. The first-year governor was merely following precedent set by recent Mississippi governors of both parties.

Reeves's proclamation didn't mention slavery. It did offer insight into how the state's top executive hoped to continue to frame the state's decision to secede from the Union and Mississippi's decision to continue to claim the Confederate battle flag as its own.

"It is important for all Americans to reflect upon our nation's past, to gain insight from our mistakes and successes, and to come to a full understanding that the lessons learned yesterday and today will carry us through tomorrow," Reeves's statement said.

The Mississippi chapter of Sons of Confederate Veterans praised the statement. U.S. Rep. Bennie Thompson, the state's only African-American congressman, denounced it as "unnecessary."

After Floyd's death sparked protests across the nation and beyond, the tone changed in Mississippi. Its lawmakers decided it was time to finally distance Mississippi's flag from the Confederacy.

Anderson, now a senior partner at Phelps Dunbar, a regional law firm, was appointed to lead a state commission to choose a new Mississippi flag design. The pick, approved by voters last November, features a magnolia, the state flower. It was a public service Anderson felt honored to provide.

"Honestly, I never thought I'd live to see the Confederate battle flag removed from Mississippi," Anderson said after Governor Reeves signed a law retiring the state's 126-year-old flag.

HAMILTON, the Kentucky sculptor who has created public monuments on display in several states, recalls his own work with the Confederate flag.

For a memorial he was commissioned to build in Louisville to honor Abraham Lincoln—who presided over the Union during the Civil War and issued the 1863 Emancipation Proclamation declaring "all persons held as slaves" in Confederate states to be free—Hamilton designed a statue that included four bronze reliefs depicting stages of Lincoln's life.

In one of the reliefs, which are spaced several feet apart in a walk-up to a huge statue of a seated Lincoln, a battle scene is depicted with the Confederate flag flying near the top of the sculpture. On the left side, Lincoln ushers away a crying First Lady Mary Todd Lincoln. The right-side relief depicts the first lady's half sister, Emilie, on the ground, holding the hand of her dying husband, who was an enslaver and a Confederate general. The art is designed to tell the story of how the war divided not only the country but also families, including Lincoln's.

"I could not tell the story effectively if I had not portrayed an accurate depiction of the flag," Hamilton says. "It is an important piece of the story. The authenticity of the story would be diminished if I didn't include the flag."

He says being an effective storyteller requires more than his skills as an artist—it requires digging deeply into the history he's trying to display.

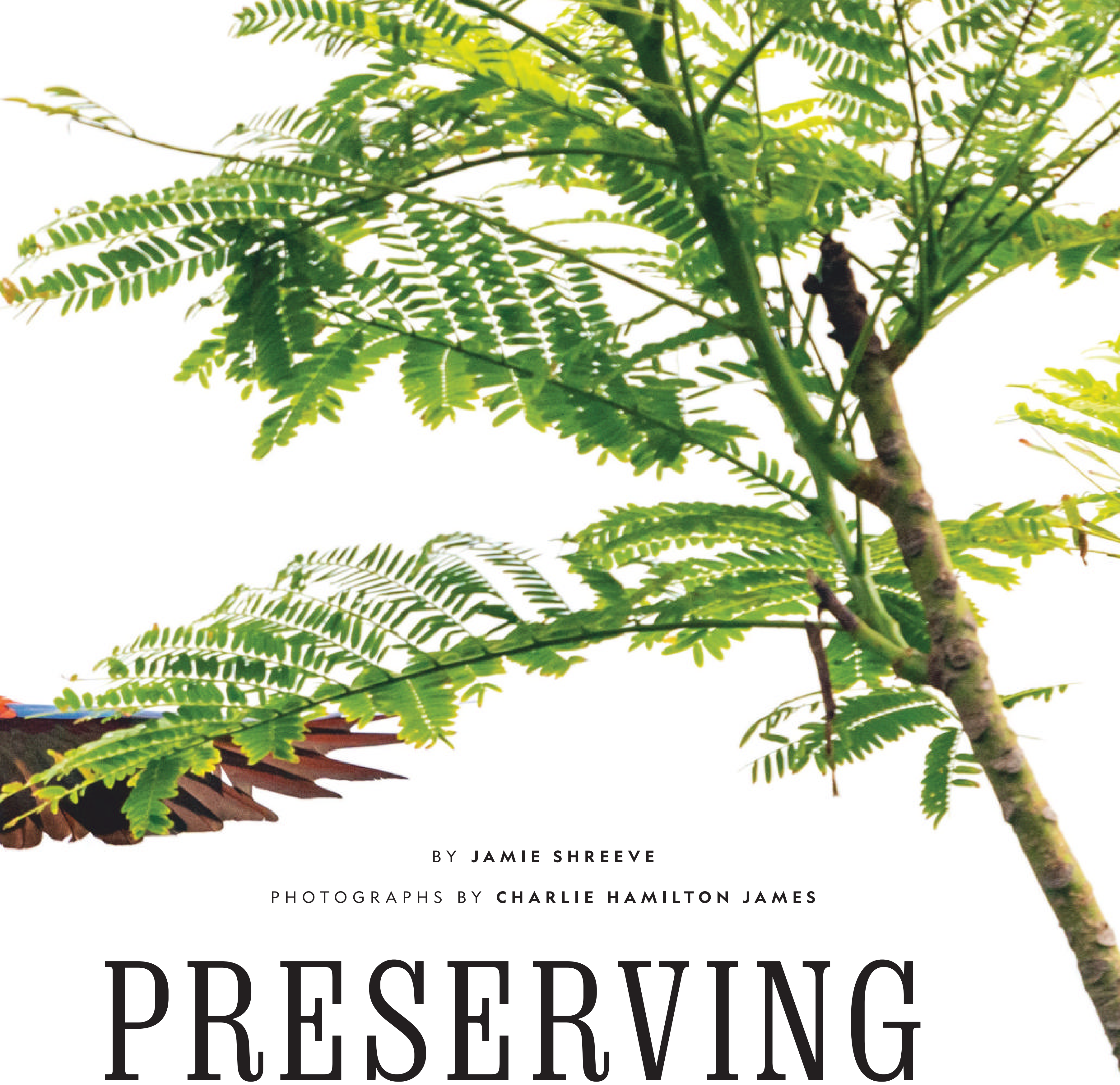
Hamilton also designed the "Spirit of Freedom" sculpture for the African-American Civil War Memorial in Washington, D.C. For that, he says, "I was motivated in part with knowledge I gained after learning that 209,000 Black soldiers fought in the Union Army and about 20,000 Black men served as sailors in the fight for Black freedom. Why didn't I know this before I designed the monument?

"Because it was never taught to me in any of my history classes." □

Phillip Morris is a Cleveland-based journalist who often covers issues of race, class, and culture. **Kris Graves** uses photography to explore societal problems, race, representation, and memory.

A pair of scarlet macaws livens up a fern tree on Costa Rica's Osa Peninsula. The species is threatened by habitat loss and the pet trade through most of its range, but the Osa population is thriving—a vibrant symbol of a conservation success story.

DAVID PATTYN
NPL/MINDEN PICTURES



BY **JAMIE SHREEVE**

PHOTOGRAPHS BY **CHARLIE HAMILTON JAMES**

PRESERVING PARADISE

COSTA RICA'S OSA PENINSULA IS A **MODEL FOR CONSERVATION.** NOW COVID-19 IS **TESTING PROTECTIONS** FOR THIS NATURAL WONDER.

Forest crowds the beach at Cabo Matapalo, a famed surfing spot on the southern tip of the Osa Peninsula. Conservation efforts are tied to income flowing from the tourist trade, which has been reduced to a trickle by the pandemic.

C

CELEDONIA TELLEZ doesn't recall the year she moved to the Osa Peninsula, or exactly how old she was, but she remembers well why she came: free land. At the time, the peninsula, a 700-square-mile crook on the southern Pacific coast of Costa Rica, was a forest frontier, separated from the mainland by a neck of near-impenetrable mangroves and accessible mainly by boat. Celedonia was pregnant when she arrived with her five children, six chickens, a dog, and 700 colones, about one dollar. She also brought her boyfriend, but he "hated nature, and would run away from insects," she remembers. So she took an ax and cleared the land herself.

"When I was cutting down the trees, I would think how they must have taken so long to grow, and I cut them down in an instant," she says. "That's what we did. We cut down the forest to live."

Some 40 years later, Doña Celedonia, as she is respectfully called by everyone, still lives on that same tract, in a town called La Palma. When I met her on a June day in 2019, she was wearing jeans and a blue and white floral print blouse. She showed me around her garden and house, and from her confident stride there was no telling that she is nearly blind.

Botanist Ruthmery Pillco Huarcaya gathers seeds from a wild nutmeg tree in the Osa's remaining patches of old-growth forest. New trees grown from the seeds will be planted in degraded areas, with the hope of luring spider monkeys and other seed dispersers. "The trees you plant may die," Huarcaya says, "but the trees the animals plant—they will re-create the original forest."

For Doña Celedonia, it was a day of redemption: Instead of clearing the forest, she was bringing a bit of it back. At her invitation, a nonprofit called Osa Conservation had organized a network of local and government groups to plant 1,700 native tree saplings on her 22-acre farm, most along a stream defining one border of her property. On Costa Rica's annual Arbor Day, many of her six children, 16 grandchildren, and 14 great-grandchildren had gathered to celebrate, along with much of the rest of the surrounding community. There were displays, speeches, games, and dances by the children in brightly colored traditional dress.

Toward noon, everyone ambled out to the stream to watch Doña Celedonia plant the symbolic last tree. Her grandson Pablo dug a hole. Seeming embarrassed by all the attention, Doña Celedonia bent from the waist and lowered the root ball into the ground.

"Maybe I'll turn my whole farm back into forest," she said, wiping the dirt from her hands.

ACRE FOR ACRE, the Osa is one of the most fecund flecks of land on Earth. Though it occupies less than a thousandth of a percent of the planet's surface, it harbors 2.5 percent of its life-forms. The peninsula's assortment of habitats—cloud forest, lowland rainforest, swamps,

The nonprofit National Geographic Society, working to conserve Earth's resources, helped fund this article.

mangroves, freshwater and coastal lagoons—offers refuge to thousands of species, including boisterous populations of scarlet macaws, spider monkeys, and other animals that have disappeared or are dwindling through most of their historic range. Five species of wild cats prowl its forests, four species of sea turtles trundle up its Pacific beaches to lay eggs. To the east, hammerhead sharks and humpback whales course up the Golfo Dulce fjord to give birth.

The Osa's ecosystem, however, is fragile. Twice in the past it has been on the brink of destruction—not by large commercial interests so much as by the incremental impact of ordinary folk cutting down the forest to live or panning the Osa's rivers for a few dollars' worth of gold. In recent years, some Osa communities have become passionate defenders of the environment they once exploited. Instead of cutting down ancient trees for timber, they cut trails for ecotourists; instead of illegally tracking game, they track illegal hunters.

But now the area is facing a new threat. The COVID-19 pandemic has devastated the Costa Rican economy, shutting off the spigot of tourist dollars that has underwritten the shift toward environmentally sustainable livelihoods. The hearts and minds of Osa people are turning toward a conservation ethic. But they still have stomachs.

"People here are close to nature," says Hilary Brumberg, the Osa Conservation staffer who led the reforestation project on Doña Celedonia's farm. "But when it comes to feeding your family or protecting nature, the family will come first."

ANDY WHITWORTH, Osa Conservation's 37-year-old executive director, wears his love of wildlife literally on his skin: Tattoos of snakes, lizards, gharials, and hummingbirds adorn his arms, while a greater horned rhino grazes across his chest. He joined the organization in 2017, after six years fighting a dispiriting battle for conservation in the Peruvian Amazon.

"When I came to Osa, I suddenly felt hopeful again," Whitworth told me over breakfast at Osa Conservation's biological station, in the southwest of the peninsula. "In the Amazon I'd see spider monkeys once or twice a year. Here, it's once or twice a day. It was transformational."

Whitworth was quick to give some credit for Osa's success to Costa Rica's pioneering reforestation policies. Through most of the last half of the 20th century, the forests that once covered 75 percent of the country were systematically denuded for timber, cattle, and crops such as bananas and pineapples. In less than a generation, scarcely a fifth of the land remained tree covered.

But in the mid-1990s the government took action not just to halt the trend but to reverse it. It passed a law prohibiting the cutting of any trees without a detailed management plan and initiated a program to pay landowners to maintain their forested terrain and plant new trees, funded through a national tax on gasoline. In merely 25 years, Costa Rica's forest cover has more than doubled, and the country is well on the way to its goal: trees blanketing 60 percent of the land by 2030.

If the electric company cuts down a tree, Whitworth told me, it has to provide funds to plant five. Laudable, but hardly an end in itself, he said.

"Just promoting forest cover is dangerous. You could end up with empty forest. What we're focused on is restoring the entire ecosystem."

During the past several years, a network of camera traps that Osa Conservation coordinates with universities, private landowners, ecolodges, and other local groups is revealing how well the forests are filling up. A study in the 1990s, Whitworth said, found virtually no wildlife in the Osa beyond Corcovado National Park, which covers most of the west side of the peninsula. Now they're seeing animals where they had previously been hunted out.

Pumas, once rare in the park and never seen beyond it, are recovering. Ocelots too are rebounding in force, as are jaguarundis, another small cat. Collared peccaries—a piglike mammal—are abundant in the Piedras Blancas, a national park on the far side of the gulf. White-lipped peccaries, a related species, aren't faring as well yet beyond Corcovado Park—perhaps not unexpected, since they're prized for their meat and move in big herds easily targeted by hunters. The white-lipped peccaries are favorite prey of jaguars, and they too have struggled to rebound beyond the parks' borders.

Ultimately, the only way to ensure the health of the Osa ecosystem is to grow it. To that end, Osa Conservation is helping to fill in the forest by planting trees on strategically located private farms such as Doña Celedonia's. In the short term, plantings along rivers and streams in cultivated areas give shade for farm animals, help prevent soil erosion, and provide habitat for birds and other wildlife. But the long-term goal is to create an unbroken corridor of green, arcing from Corcovado across to Piedras Blancas, and eventually to the vast La Amistad International Park in the Talamanca Mountains, shared by Costa Rica and Panama. This will require not just eco-friendly government policies but also buy-in on the ground, one farmer or rancher at a time.

"The national strategies have initiated this great forest change," Whitworth told me. "But the real connection to wildlife comes from the bottom up."

One reason for the abundance of species in the Osa is the paucity of one in particular. Until the 1960s, the peninsula was inhabited only by a gnarled handful of gold miners, squatters, and fugitives, whose reputation for lawlessness helped keep the general population at bay.

"It was a pretty rough bunch of boys," remembers Patrick O'Connell, who as a young man found his way down from Indiana to the Osa to hunt and stayed, making a living by walking from one miner's camp in the jungle to another's, buying gold. "Nobody died of old age."

At the time, 80 percent of the peninsula was still old-growth forest. That began to change in the early 1970s, when, encouraged by the completion of the Inter-American Highway South, the population doubled to about 6,000 people, primarily occupying the cultivated strip on the eastern side of the peninsula. Most of the undeveloped land was owned by a transnational timber company too distant and badly managed to exert much control, so whoever could clear a piece of land could call it their own.

Meanwhile, a biological research station on the peninsula had also attracted another human subspecies: foreign scientists, more than a thousand of them visiting during the 1960s. As settlers pressed into the rich Corcovado Basin on the western side of the peninsula, scientists helped sound the alarm: Unless a park was created to protect it, the Osa's forests and the biodiversity they contained would vanish. Spearheaded by Álvaro Ugalde, the father of Costa Rica's park system, the government negotiated a complicated land swap with the timber company, leading in 1975 to the creation of Corcovado National Park.

There remained the problem of removing from the park's boundaries some 250 entrenched settlers, who viewed the timber company, the park rangers, and the scientists with equal degrees of hostility. In the end, most agreed to move to land provided for them on the eastern side, spurred by payments totaling more than a million dollars for "improvements" to the land, such as deforestation, crops, and buildings.

For several years there was little disturbance in the park. But then the price of gold began to soar. Coupled with widespread unemployment elsewhere in Costa Rica, the prospect of making a fortune, or at least scraping out a living, triggered Osa's second crisis. By the early 1980s, some 1,400 miners were working illegally in the park.

"The damage was huge," says Dan Janzen, a prominent Costa Rica–based environmentalist recruited in 1985 to conduct a study of the miners' impact. Almost all of the animals in the southern third of the park had been hunted out to feed the mining communities. The rivers had become what Janzen describes as "liquid deserts," the shrimp, crabs, and other aquatic life blighted by sediment from the miners' operations clogging the riverbeds downstream.

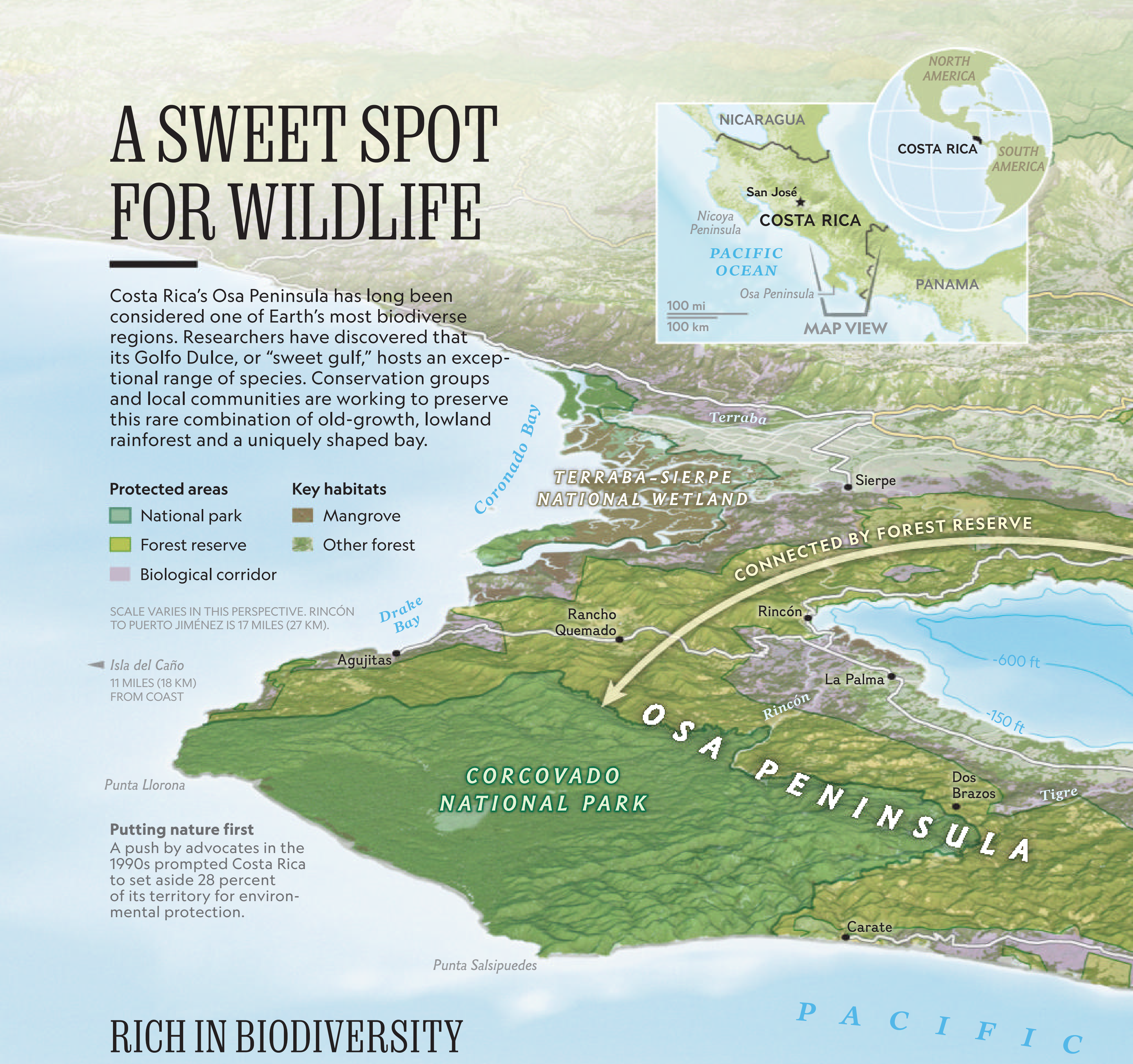
Instead of using what he calls "guns and gold badges" enforcement to chase the miners out, Janzen recommended taking a year to get to know them and persuade them to leave on their own or face arrest. It worked, but in subsequent years the government often reverted to a more militaristic approach, which only exacerbated the local people's resentment.

Nowhere was the guns-and-gold-badges approach applied more clumsily than in Rancho Quemado, near the center of the peninsula. The settlement had been carved out of the forest in the 1960s by a family named Ureña from

> 'People here are close to nature, but when it comes to feeding your family or protecting nature, the family will come first.'
>
> Hilary Brumberg, Osa Conservation

A SWEET SPOT FOR WILDLIFE

Costa Rica's Osa Peninsula has long been considered one of Earth's most biodiverse regions. Researchers have discovered that its Golfo Dulce, or "sweet gulf," hosts an exceptional range of species. Conservation groups and local communities are working to preserve this rare combination of old-growth, lowland rainforest and a uniquely shaped bay.



SCALE VARIES IN THIS PERSPECTIVE. RINCÓN TO PUERTO JIMÉNEZ IS 17 MILES (27 KM).

Putting nature first

A push by advocates in the 1990s prompted Costa Rica to set aside 28 percent of its territory for environmental protection.

RICH IN BIODIVERSITY

More than 140 mammals, 460 birds, and thousands of plants and insects, many of them endangered, have been identified in the 700 square miles of land and 120 miles of coastline that make up this vital ecosystem.

Mammals of the rainforest

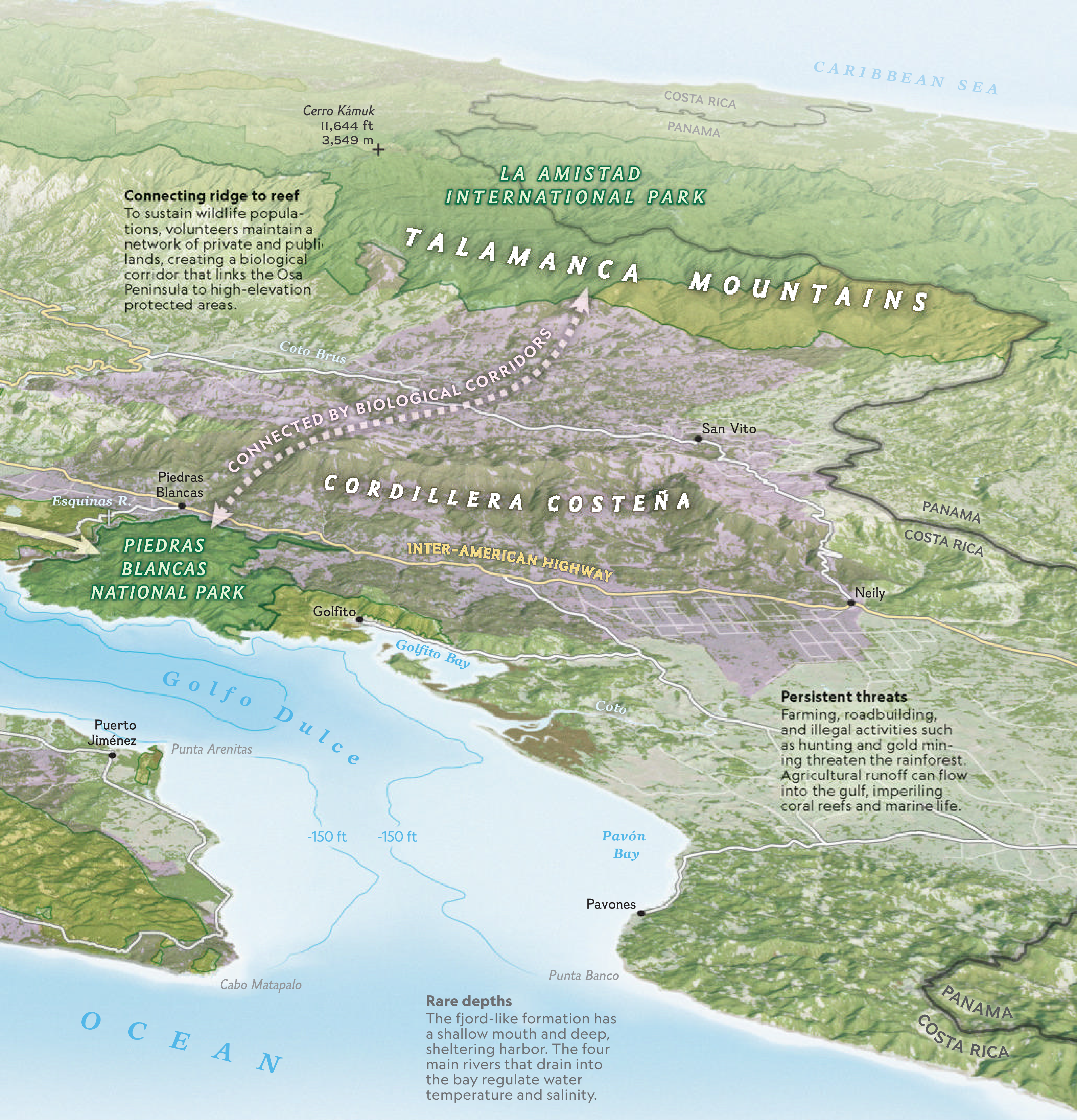
Pumas and collared peccaries, among other mammals, are recovering in this tropical landscape. Survival of wildlife in the region depends on an expanding habitat and a diverse gene pool.

Mangroves

These saltwater-tolerant trees carpet the region's shorelines and wetlands. A refuge for hundreds of land and marine species, they're also critical to preventing coastal erosion.

Ground roots, which reduce storm-force waves during turbulent weather, also filter pollution and debris that can wash into the ocean.

RILEY D. CHAMPINE AND MANUEL CANALES, NGM STAFF; ALEXANDER STEGMAIER. ART: MATTHEW TWOMBLY
SOURCES: HILARY BRUMBERG, NOELIA HERNÁNDEZ, AND ELEANOR FLATT, OSA CONSERVATION; NASA; CIMAR, UNIVERSITY OF COSTA RICA; GEBCO; ESA CLIMATE CHANGE INITIATIVE LAND COVER PROJECT; WDPA



Connecting ridge to reef
To sustain wildlife populations, volunteers maintain a network of private and publi lands, creating a biological corridor that links the Osa Peninsula to high-elevation protected areas.

Persistent threats
Farming, roadbuilding, and illegal activities such as hunting and gold mining threaten the rainforest. Agricultural runoff can flow into the gulf, imperiling coral reefs and marine life.

Rare depths
The fjord-like formation has a shallow mouth and deep, sheltering harbor. The four main rivers that drain into the bay regulate water temperature and salinity.

Hammerhead sharks
After mating in open waters, scalloped hammerhead sharks birth their young here from March to August. Scientists are now studying their movements and behavior.

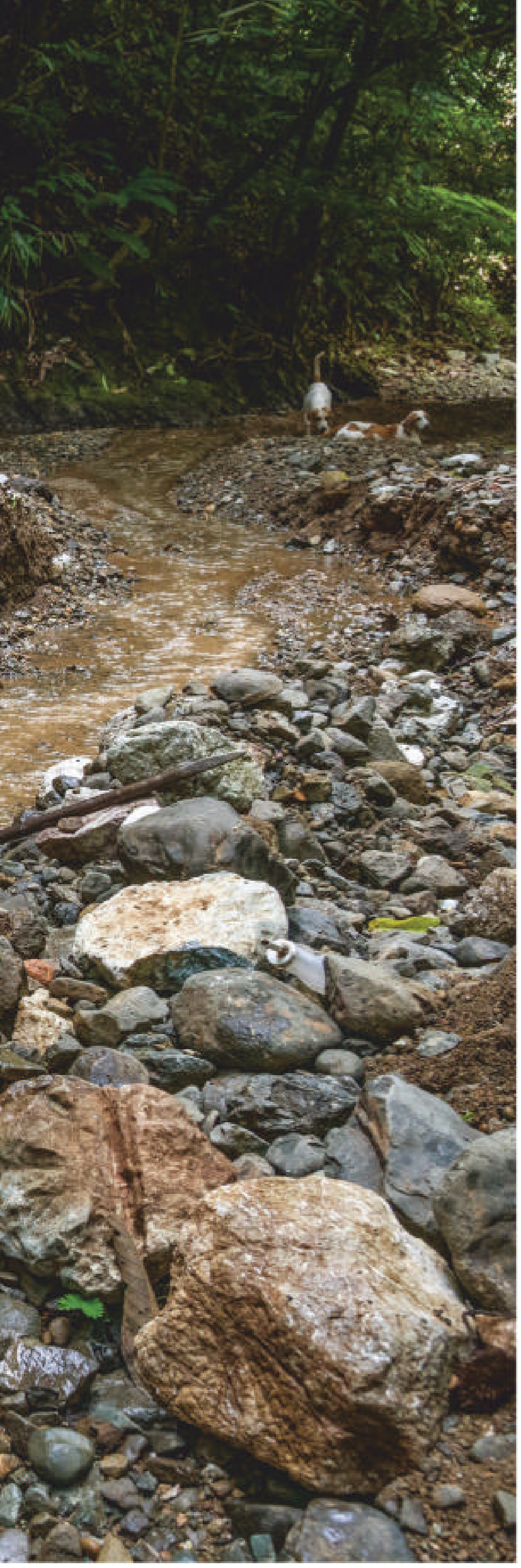
Humpback whales
The Osa Peninsula is the only known area that's a nursery for both northern and southern humpback calves. Average water temperatures of 80°F help them maintain body heat.

A puma fixes on a camera trap, perhaps alerted by the shutter's click. A network of such traps deployed by conservation groups, ecolodges, and local people reveals that populations of pumas and three other wild cat species have rebounded on the peninsula since the late 1990s. Jaguars are still scarce.

Buenos Aires. Its people, like others on the peninsula, subsisted by growing crops and hunting wildlife. Every other year a herd of white-lipped peccaries would come through Rancho Quemado from the park, and every time, hunters in the village would kill about 80 percent of the animals. In 2008, however, the peccaries were accompanied by rangers, some of them armed. With their own guards to protect them, the peccaries became fearless, chowing down on the villagers' crops and wandering freely in the fields and streets, while the townspeople watched helplessly. It was a short-term win for conservation: Villagers killed only five peccaries that year. But long term, it deepened the divide between the park and the people.

WHEN I VISITED Rancho Quemado 11 years later, the town had a very different energy. I was tagging along with Marco Hidalgo, the community outreach manager for Osa Conservation. At the open-air restaurant of Enrique Ureña, a nephew of the family's patriarch, the peccaries' seasonal migration through the village was again the topic of conversation—only now the matter at hand was how to protect the animals instead.

Ureña, once among the most vocal opponents of the park, worried that the rangers were stretched too thin; what was needed were local volunteers who could escort the peccaries as they moved about. Hidalgo mentioned that Osa Conservation had a peccary surveillance project under way using radio collars on individual



Two gold miners work a stream near Corcovado National Park. Hand panning for gold, for decades a way of life on the Osa, is illegal throughout Costa Rica because it pollutes the environment, but the government tolerates a few artisanal miners. Some communities formerly dependent on mining have successfully redirected their economy to ecotourism.

animals so the movements of their group could be easily tracked.

"The ones you want to put collars on aren't the peccaries," Ureña's elderly mother, Espiritu, interjected, from where she sat apart on a sofa in the corner. "It's the hunters."

Rancho Quemado's transformation was wrought through necessity—there wasn't enough employment for everyone—but its direction was determined by education. In 2002, Ureña and 14 other villagers ranging in age from 14 to 60 took an intensive course in forest biology. The students learned, among other things, how peccaries function as "ecosystem engineers." They disperse seeds, create habitat for aquatic life with their wallows, and alter the structure of the forest by eating the seeds of common plants, allowing diverse rarer ones a chance to compete.

With the understanding that the biodiversity surrounding them was a natural draw, residents also learned how to set up ecotourist operations. Now the village monitors peccary movements, conducts bird counts, maintains camera traps, collects tree seeds, and offers forest hikes and educational programs for children. Hidalgo has helped guide and encourage this change of heart but takes no credit for its success.

"They took the tools and changed themselves," he said.

By no means have all of the Osa's communities undergone such a metamorphosis. Hidalgo told me that Los Angeles de Drake, a village in the northern part of the peninsula, is so rabidly anti-conservationist that when his work takes him there, he has to park his car behind the locked school gate so it won't be vandalized. But—in 2019 at least—there was a sense in many of the people I met of a profound shift toward a protective view of nature.

I spent two days with Tomas Muñoz, who grew up in Dos Brazos de Rio Tigre, another town formerly dependent on illegal mining that has turned to ecotourism to survive. Muñoz started hunting when he was 10 and began panning for gold two years later. He estimates that from the age of 14, when he dropped out of school, he spent 25 days out of every month in the jungle.

He learned all the ways of the forest, including how to evade the rangers and police. (Walk only on roots and stones so you don't leave prints; don't wash in the creek where you're camped, since the suds will show up downstream; and don't use any lotions or sunscreen because unusual odors are easy to detect in the forest.)

"Once I smelled 3-in-One oil from the rangers' guns," he told me. "They were 80 meters away. We all scattered and watched them pass on the other side of the river. They never caught me," he added with a little smile. "I ran too fast."

When he was 20, Muñoz stopped hunting because one of his uncles, who worked as a guide himself, convinced him that he was wasting his life; he could make a much better living leading tourists to the animals than killing them for meat. But it wasn't easy to overcome the atavistic tug toward his former ways.

"My uncle took me to a ranger station where

The peninsula's assortment of habitats—cloud forest, lowland rainforest, swamps, mangroves, freshwater and coastal lagoons—offers refuge to thousands of species.

A pod of spinner dolphins cruises off Isla del Caño, in the Pacific Ocean roughly 15 miles west of Drake Bay. Superpods numbering in the thousands congregate along the Osa's coasts, attracted by a predictable abundance of prey.

there were wild chickens and peccaries up close to me," he recalled. "My instinct was to look for a stick or a rock—anything to kill them. It was in my brain. It took me two years before this feeling went away."

Muñoz told me his story as we walked along a slate gray beach toward the southern entrance to Corcovado Park. Pelicans glided in formation above the breakers on one side, and the forest canopy rose abruptly on the other, like a towering green thunderhead. We spent the day in the park, Muñoz carrying the tripod for his spotting scope over his shoulder like a rifle, stopping abruptly to lure some spider monkeys closer with a call or to point out a crested caracara, a family of capuchins, a tiny Golfo Dulce poison dart frog, or a white-nosed coati nibbling on a Halloween crab.

The next day he took me to visit his village of Dos Brazos, which boasts its own trail into the park from the eastern side. It was built by the villagers themselves, mostly former gold miners. Muñoz helped train some to be guides, while other villagers provide tourist lodging, meals, and cooking classes. The trail doesn't connect with the park's formal network of trails, but it is easier to access, and it offers some of the best birding on the peninsula.

"Before, people just talked about the gold they got," Muñoz said. "Now the talk is more about the birds."

THE FOLLOWING spring, there were no tourists to cook for, no work for the guides in Dos Brazos or Rancho Quemado, and no volunteers at Osa Conservation to tend trees or keep predators away from the sea turtle hatchlings on the Pacific beach. Costa Rica responded aggressively to the COVID-19 threat, shutting down all foreign travel. By the end of November, when the United States had suffered 264,808 deaths, Costa Rica had recorded 1,690.

But the economic damage was catastrophic. The tourist industry collapsed, choking off funding for the country's national park system, forcing the authorities to close Corcovado in March and pull rangers from inside the park.

For a few weeks all was quiet. Then word went out on a social media chat shared by Osa tour guides: Someone was taking advantage of the lack of tourists and law enforcement to organize hunting tours within the park.

Two hunters had killed nine white-lipped peccaries—not for food but for sport. When I called Dionisio Paniagua Castro, a longtime tour guide and, since the pandemic, a conservation activist on the peninsula, I could hear his anguish over the phone.

"So many animals, for fun!" he said. "We definitely had to do something."

The guides alerted the authorities, who sent in police and made some arrests. But the park was too big, and law enforcement too thin and sporadic, to cope with an escalating debacle.

It wasn't just hunters. With both unemployment and the global price of gold rising in response to the pandemic, miners were streaming back into the park in numbers not seen in decades. Drug traffickers and loggers likewise

Swimmers prepare for the Golfo Dulce Open Water Crossing competition on the east side of the peninsula, timed to attract more visitors during the low tourist season in late summer. The swimmers will share the Golfo Dulce with humpback whales arriving from the southern Pacific in summer to birth their calves in the gulf's protected waters.

were taking advantage of the disruption.

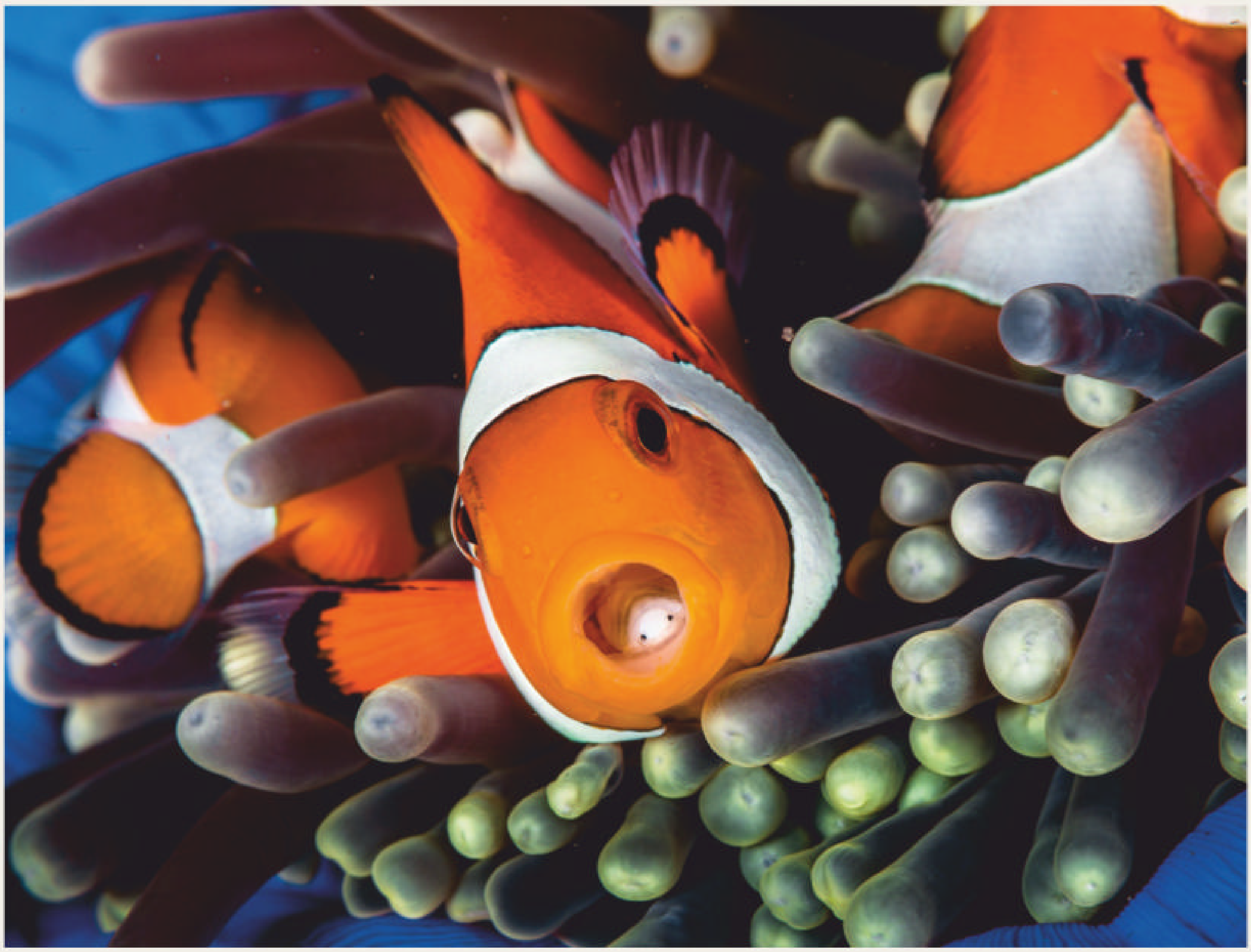
But there was another line of defense as well: the people of the Osa themselves. In response to the crisis, Carlos Manuel Rodríguez, Costa Rica's minister for the environment at the time, resurrected the notion of a cadre of 52 volunteer rangers—mostly guides and leaders from different communities, including Rancho Quemado and La Palma, who could be trained in surveillance technologies and deployed to form a buffer zone around the park.

They have no weapons, but they do have phones, cameras, and community connections, and they can quickly alert law enforcement when they spot illegal activity. Much of the problem appears to be caused by organized groups from beyond the peninsula. But as the tourist economy has collapsed, inevitably some local people have had little choice but to take up their old pans and shovels and join the illegal miners in the park.

"People have to find ways to make money, and gold mining is one of them," Muñoz told me by phone. I asked whether he was tempted himself, since he was among the guides who were out of work. There was anguish in his voice too when he answered.

"I'm trying not to go there." ☐

Jamie Shreeve wrote in the March 2019 issue about the search for life beyond Earth. Frequent contributor **Charlie Hamilton James** photographs subjects ranging from rats and river otters to elephants.



INSTAGRAM

GREG LECOEUR

FROM OUR PHOTOGRAPHERS

WHO

A French photographer whose specialty is marine wildlife

WHERE

Underwater in the Lembeh Strait, off the north edge of the island of Sulawesi in Indonesia

WHAT

A Nikon D7200 with a 105mm lens in a Nauticam housing and two strobes

Indonesia's coral-filled waters are famous for their biodiversity and for species that use mimicry, alliances, and symbiosis to survive. On a dive, Lecoeur noticed this clown anemonefish had a small companion. The parasite *Cymothoa exigua* attaches to a fish's tongue and siphons blood. The tongue withers, but the parasite stays, feeding off the host while the fish pursues its usual diet. Getting the shot took immense patience, Lecoeur says—until, for a fraction of a second, the fish looked at the camera and opened its mouth.

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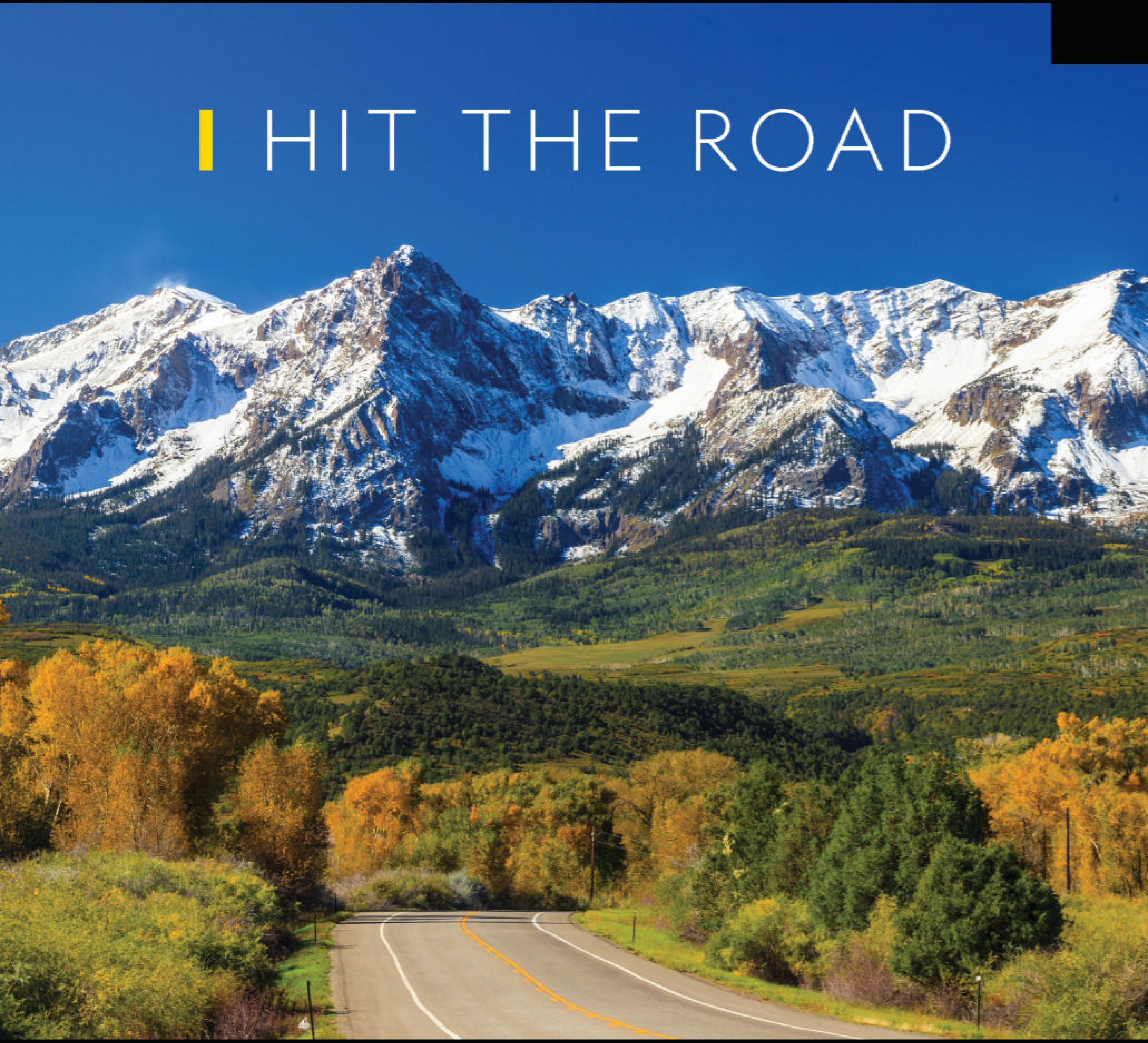

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